

Experimental and Research Station,

Nursery & Market Garden Industries'

- - Development Society, Limited. - -

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Introduction.

THE Experimental and Research Station, which was started in 1914 under the auspices of the Nursery and Market Garden Industries' Development Society, continues to develop its activities in all branches. The number of inquiries and problems submitted for investigation is still increasing, and from the results obtained in commercial nurseries it is evident that the Station is providing a good deal of practical assistance to growers who are in difficulty. While contact with growers has always been one of the happy features of the work, it has been possible to strengthen this relationship by the appointment of Mr. O. B. Orchard, who will be available for visiting nurseries. It is anticipated that growers will take full advantage of this new development.

Membership of the Society, under whose auspices the experiments are conducted, is open to all growers and interested persons. Subscriptions are payable at the rate of two guineas for each acre of glass cultivated by the subscriber; in return members receive future publications and any advice which is available. Members continue to be enrolled but many more are needed, both to provide additional funds for research and to obtain complete co-operation in controlling the various pests and diseases common to glasshouse plants. Serious outbreaks over a wide area must be fought by all growers; isolated attacks are almost bound to fail.

It has been evident for several years that the existing laboratory accommodation is quite inadequate and further extension of the building became an urgent necessity. A suitable scheme was prepared after consultation with the Architect, Major H. P. G. Maule, and the Ministry of Agriculture. The total cost was estimated at £8,100, and to qualify for a grant in aid of this work the Station Authorities were required to raise the sum of £1,900.

This proved unobtainable and it was reluctantly decided to curtail the extension and reduce the cost to £4,200, three-quarters of which was provided by the generosity of the Ministry of Agriculture. The remaining sum of £1,050 has been contributed by business firms and private donors, to whom our grateful thanks are offered. A list of subscribers will be found in the Appendix. Building has been in progress for some time and is expected to be completed by the end of March, 1932. While money is not available to equip fully the new laboratories, the increase in accommodation will greatly assist the work of the Staff.

A recent addition to the experimental houses is a rose house 100 ft. long by 20 ft. wide, the gift of the National Rose Society. This house will be devoted to the investigation of rose diseases, and a grant of £60 per annum has also been provided by the Society towards the cost of such investigations. Part of the land on which this house has been erected was presented to the Station, in 1929, by Mr. H. O. Larsen, and part by the sons of the late Mr. R. Cobley, whose nursery adjoins the Station property on the south side.

Our grateful thanks are due to the National Rose Society and to the above gentlemen who have contributed so generously to the development of our work. There is still room for a carnation house, a vine house, a pot-plant house, and a mushroom shed; any contributions towards the cost of these will be gratefully received.

Endowment Fund.

An Endowment Fund has been opened to receive contributions from those who desire to further the work of the Station. The capital will be vested in Trustees and the interest only will be used for (a) future development, (b) repayment of debt.

Major E. J. Monro and Mr. H. O. Larsen have kindly consented to act as Trustees, and any expenditure can only be incurred with their sanction. A third Trustee has not yet been appointed.

Evening Discussions.

The evening lectures for nursery owners and employees, commenced in 1925 at the request of the workers, were continued, the subjects selected being as follows :—

1930.

Nov. 3rd.—The Growth of Plants. Mr. B. D. Bolas, M.Sc., D.I.C.

Nov. 24th.—A Visit to Holland. Messrs. J. C. Cobley and E. S. Shoults.

Dec. 8th.—The Heating of Glasshouses by Fuel Oil. Mr. N. L. Hudson, M.I.N.A.

1931.

Jan. 19th.—Leaf Mould of the Tomato. Mr. T. Small, M.Sc., A.R.C.Sc.

Feb. 2nd.—Lilies. Mr. E. A. Bowles, M.A., F.L.S., V.M.H.

Feb. 16th.—The Royal Palace of Theobalds. Mr. J. C. Cobley.

Mar. 2nd. Roses. Mr. W. B. Chaplin.

Mar. 10th. Open Night.

Our grateful thanks are due to the Lea Valley Growers' Association who so kindly provided a grant to cover the cost of hiring the lecture room and supplying light refreshments each evening.

Current Investigations.

Manurial and crop management trials with tomatoes have been continued. The experiments relating to the relative effects of different nitrogenous fertilisers were adversely affected by an attack of wireworm, but there were indications that organic forms of nitrogen are more effective on tomatoes than the inorganic forms. Finely ground hoof and horn and fish manure gave the highest yields in this series during the season.

The experiment in which some plants were "stopped" at the fifth truss and others allowed to continue vertical growth unchecked has been repeated over a period of years, and previous results are confirmed, namely, that the heaviest crop results from unchecked growth. While picking commences some three to seven days earlier from the "stopped" plants, the weight of fruit gathered by the end of June is similar in each case.

Houses which were steamed for 1931 showed a crop increase of 24% over the control, while treatment with formaldehyde gave little response. The latter result may be associated with the unsuitable weather conditions which prevailed. The addition of old tomato roots to soil previously steamed reduced the yield some 9%, the harmful effect being noticed after the end of June.

A good type of *Sphagnum* peat, incorporated with the top 12 inches of soil after steaming, proved beneficial and increased the yield 14% over that obtained from steaming alone. When added in a similar manner to soil previously treated with formaldehyde the crop increase was only 4%. An excellent result, probably of considerable significance, was obtained by digging clean chrysanthemum roots into a plot previously steamed. A yield of 55 tons per acre was recorded, equal to the crop obtained from this plot during the first year of cultivation. The use of plain wheat and oat straw applied at the rate of 3 tons per acre to the top spit and a similar quantity to the second spit has proved useful on several nurseries and is worth further trial, especially in old nurseries.

The liming experiments have been continued with results similar to those obtained previously. It would seem that the value of lime for tomato soils has been over-estimated except in cases where it is necessary to improve the tilth.

The Variety trials included a number of new crosses of which Tuckswood $\times$ E.S. 1 proved the best. The work of breeding good cropping varieties resistant to Leaf Mould is also being continued, and certain stocks have been selected for trial on a larger scale next year.

Through the kind co-operation of Messrs. Shell Mex, Ltd., who installed a completely automatic oil fired boiler at the Station, it has been possible to examine this form of heating for glasshouse work. Excellent temperature control was observed, and there are indications of increased crop production and greater freedom from Leaf Mould as the result of the more uniform temperatures obtained by this method.

The cucumber experiments were designed to test the effect of reinforcing the normal beds of soil and stable manure with a proportion of plain wheat straw. The effect on heavy virgin loam was compared with that when baked old cucumber beds were used.

As in previous years, the crop was improved by rendering the bed more open by occasional top-dressings of plain straw. Good crops were grown in beds made up of baked cucumber soil and straw only; the virgin soil did not contain sufficient nitrogen and required some stable manure in addition to the straw.

No improvement in crop production was observed from the addition of peat to the beds.

Golden Ball and Tom Thumb lettuce have been grown successfully during the past four years as a catch crop before tomatoes. The young plants are set out in unheated houses during December, leaving room to plant tomatoes between the rows. The lettuce crop has been removed within four or five weeks of planting tomatoes.

The Red Spider investigations have been continued and the use of a sulphonated oil product as an alternative to petroleum oil emulsion sprays for controlling this pest has been investigated. When used at a spraying strength of 1 part by volume in 250 parts of water complete control of the mite was obtained. At this strength the cost is approximately one-half that of the ordinary petroleum oil emulsions.

The examination of different series of chemically-related compounds with regard to their action as fumigants has been continued and previous findings regarding the

effect of molecular structure have been confirmed. In the presence of plants there is a considerable reduction in the toxicity of the higher members of the methyl esters of the fatty acid series, which reduces their potential value below that of methyl formate.

The breeding and distribution of the White Fly parasite, *Encarsia formosa*, Gehan, has been continued. The demand for this material continues to be as great as in former years.

The larvæ of the Cucumber Root Flies, *Plastociara perniciosa*, Edw., and *Phyxia scabiei*, Hopk., caused considerable damage to commercial crops. Reasonable control of these pests in beds has been obtained by thoroughly drenching the soil with a 0.1% solution of mercuric chloride.

The use of Salicylanilide in the form of a 50% paste (known as Shirlan paste), in conjunction with Agral 1, has been tested and established on commercial nurseries as a control of Tomato Leaf Mould, caused by *Cladosporium fulvum*.

Temperature investigations of the soil and air have been continued during the current year, and have shown that although under normal heating conditions in glass-houses the optimum temperature for tomato growth is around 63°F. to 65°F., the crop yield can be appreciably increased by increasing the air temperature to 68°F., when the temperature of the soil is also raised to approximately the same degree.

Preliminary experiments in which the temperature of a cucumber bed was raised to 85°F., by means of electrically heated wires, indicated that the yield can be increased by 50% while the heating continues.

A method of heating the soil for tomatoes by buried pipes through which hot water is circulated has been tested. Although maximum temperatures of 90°F. were obtained the crop increase was not appreciably above that produced when the soil temperature was maintained around 80°F.

Raising the soil temperature to 80°F., however, increased the yield 20% over that from the unheated control beds.

The mosaic disease investigations have been continued, and the importance of clean seed has been emphasised.

The effect of the virus on the metabolism of the tomato plant has been studied. Preliminary results suggest that under conditions of high temperature and high light intensity there is at first an increase in the carbohydrate content of tomato plants infected with aucuba mosaic, followed by a reduction. During the winter when the light intensity was low the period of carbohydrate increase was greatly prolonged.

A form of this disease, known to growers as "peppery stripe," has proved to be the result of infection with a mixed virus. Comparative studies with this disease and "Stripe" disease have been started.

By means of a drained concrete tank in one of the tomato houses the examination of drainage water has been commenced, to determine the composition of the leachings from tomato soil and the fluctuations in composition. The information so far obtained indicates that appreciable losses of potash and nitrogen (chiefly as nitrate) occur in this way. Only the faintest traces of phosphates have been found in the drainage this year, and on no occasion were nitrites detected in measurable amounts. It appears likely that the heavy falls in the nitrate contents of a tomato soil, already recorded in earlier reports, are largely due to leaching.

DIRECTOR'S REPORT.

1. Experimental Results of 1931.

The practice of grading the tomato fruits from the experimental plots, adopted in 1931, was continued during the present season. The fruits were collected in numbered baskets and graded in eight grades as follows :—

A.—“Pinks” number 5 to 7, and “Pink and White” 8 to 10 to the lb. These are the best quality of fruit in size, shape and colour; “Pinks” being slightly larger than “Pink and Whites.”

B.—“Whites.” These fruits are of good colour but smaller than “Pink and Whites.”

C.—“Blues.” This grade consists of fruit of good colour but larger and more irregular in shape than Grade A.

D.—“Roughs.” Small mis-shapen fruits about the size of cherries.

E.—Blotchy fruits which ripen irregularly.

F.—Fruits showing Blossom End Rot.

G.—Fruits showing the lesions of Stripe Disease.

H.—Fruits showing “Green Back.”

1. Tomatoes.

(a) Houses 3 and 4. Fertiliser experiment.

The soil in both houses was removed to a depth of 18 inches in 1929 and a good turfy loam substituted for 1930. The soil was flooded with water, limed and treated with bone flour and sulphate of potash; stable manure was not applied. The houses were divided into plots 12½ feet square and used to test the relative value of different nitrogenous fertilisers applied as top dressings. Inorganic forms were used in House 3 and organic forms in House 4.

The crop was not satisfactory in 1930, growth being too strong in the early stages. The organic forms of nitrogen proved more effective than the others, highest yields being obtained from hoof and horn, dried blood and shoddy. The experiment was repeated in 1931, but unfortunately a severe infestation of wireworm injured the plants especially in the north half of House 3 so results cannot be relied upon.

Table 1.

Variety—"Ailsa Craig."

House.	Plot.	Compound Tested.	lbs. per plant						Total tons per acre.	Average tons per acre.
			May.	June.	July.	Aug.	Sept.	Oct.		
3	5	Sulphate of Ammonia	0.12	1.06	0.64	0.22	0.33	0.35	2.72	24.86
	10	"	0.08	1.03	1.12	0.34	0.51	0.74	3.82	
	6	Nitrate of Soda	0.12	1.03	0.68	0.20	0.26	0.38	2.67	22.42
	9	"	0.05	0.89	0.90	0.32	0.45	0.64	3.23	
	8	Cyanamide	0.10	1.12	0.84	0.35	0.73	0.59	3.73	26.99
	11	"	0.09	1.00	0.88	0.42	0.48	0.50	3.37	
4	7	Nitrate of Lime	0.12	1.11	0.83	0.31	0.49	0.57	3.37	24.10
	12	"	0.10	0.74	0.66	0.35	0.71	0.41	2.97	
	7	Dried Blood	0.26	1.66	1.05	0.72	0.98	0.19	4.86	32.15
	12	"	0.35	1.12	0.80	0.75	0.44	0.4	3.60	
	4	Hoof and Horn	0.35	1.59	1.01	0.65	0.97	0.08	4.65	35.27
	10	"	0.25	2.00	1.12	0.58	0.43	0.25	4.63	
5	5	Peruvian Guano	0.27	0.94	0.82	0.72	0.80	0.07	3.62	31.01
	9	"	0.14	1.54	1.30	0.50	0.70	0.36	4.54	
	6	Fish Manure	0.20	1.97	1.26	0.57	1.06	0.22	5.28	37.13
	18	"	0.30	1.44	1.10	0.87	0.62	0.16	4.49	
	1	Shoddy	0.25	1.43	0.88	0.66	0.77	0.17	4.16	30.90
	13	"	0.29	1.40	0.86	0.88	0.44	0.10	3.97	

Table 2.

Variety—"Ailsa Craig."

House.	Plot.	Compound Tested.	Amount per dressing per plot of 16 sq. yds.	Grade of Fruit : Percentage.								Total lbs. per plant.	Total tons per acre.	Average tons per acre.
				A.	B.	C.	D.	E.	F.	G.	H.			
3	5	Sulphate of Ammonia	1 lb.	80.10	14.70	1.84	2.56	—	—	0.40	0.40	2.72	20.68	24.86
	10	" " Soda	"	77.71	9.94	7.06	3.41	0.28	—	0.80	0.80	3.82	29.04	
	6	Nitrate of Soda	1 lb. 6 oz.	78.60	12.72	2.28	3.37	0.75	—	1.89	0.39	2.67	20.29	22.42
	9	" " "	"	78.70	10.80	7.40	1.84	0.32	—	—	0.94	3.23	24.55	
	8	Cyanamide	1 lb. 4 oz.	80.48	12.06	2.66	2.15	—	—	2.39	0.26	3.73	28.35	26.99
	11	" " "	"	83.00	10.97	0.91	3.29	0.32	—	0.60	0.91	3.37	25.62	
	7	Nitrate of Lime	2 lb.	78.62	13.04	2.39	3.55	—	—	1.80	0.60	3.37	25.61	24.10
12	" " "	"	83.20	10.44	2.02	3.35	0.34	—	—	—	0.65	2.97	22.58	
4	7	Dried Blood	1 lb. 12 ozs.	79.00	10.72	4.11	2.27	0.41	—	0.62	2.87	4.86	36.94	32.15
	12	" " "	"	77.52	10.02	1.93	3.33	0.55	—	4.72	1.93	3.60	27.36	
	4	Hoof and Horn	14 lbs.	74.19	9.90	4.31	3.00	2.15	—	1.92	4.53	4.65	35.34	35.27
	10	" " "	"	74.51	13.36	2.81	2.81	1.31	—	1.31	3.89	4.63	35.19	
	5	Peruvian Guano	1 lb. 10 oz.	77.06	11.60	3.85	4.44	0.54	—	0.29	2.22	3.62	27.51	31.01
	9	" " "	"	73.79	12.75	2.44	3.54	1.97	—	1.10	4.41	4.54	34.50	
	8	Fish Manure	2 lb. 8 oz.	72.17	11.55	4.16	3.22	0.75	—	0.95	7.20	5.28	40.13	37.13
	11	" " "	"	76.84	13.33	2.47	2.47	0.67	0.23	0.88	3.11	4.49	33.12	
	6	Shoddy	14 lbs.	79.33	11.29	1.94	2.16	0.95	—	0.47	3.86	4.16	31.62	30.90
	13	" " "	"	71.80	10.82	3.02	4.04	1.76	0.50	5.04	3.02	3.97	30.17	

Table 3.

Plot.	Variety.	Treatment.	Crop yield in lbs. per plant.						Total lbs. per plant.	Total tons per acre.	Relative.
			May.	June.	July.	Aug.	Sept.	Oct.			
1	E.S.1	Not stopped	0.20	2.04	2.53	1.23	0.72	0.55	7.27	55.25	119
2	"	Stopped at 2nd and every 2nd afterwards	0.11	1.68	2.16	0.85	0.43	0.18	5.41	41.12	88
3	"	Stopped at 5th truss	0.04	2.20	1.96	0.71	0.61	0.26	6.13	46.59	100
4	"	Stopped at 2nd truss	0.02	0.94	2.12	1.26	0.82	0.54	5.70	43.32	93
5	Riverside Favourite	Stopped at 5th truss and every 2nd afterwards	—	1.82	1.52	0.67	0.40	0.17	4.58	34.81	88
6	"	Not stopped	—	1.92	1.73	0.82	0.70	0.25	5.42	41.19	104
7	"	Stopped at 5th truss	—	2.01	1.39	0.84	0.63	0.33	5.20	39.52	100
8	"	Stopped at 5th truss and every 2nd afterwards	0.04	2.13	1.41	0.63	0.47	0.10	4.78	36.33	92

The yield from the plots in House 4 and the south half of House 3 are given in Tables 1 and 2. It is interesting to note that the effect of the wireworm attack was least severe where organic fertilisers were applied. This is in accordance with observations on commercial nurseries. This year the best yield was from fish meal and hoof and horn respectively. The houses have been treated with stable manure and sterilised with steam for 1932.

(b) "Stopping" experiment.

House 1 sterilised by steam during the winter 1930-31, was devoted to a "stopping" experiment, the east side being planted with the variety E.S.1 and the west with Riverside Favourite. The treatment and the results are given in Table 3.

In the case of E.S.1 batches of plants were "stopped" at the second truss only and also at every second truss. This proved unsatisfactory, as the yield was appreciably less than when the normal practice of "stopping" at the fifth truss was adopted. Further, the fruit did not come any earlier.

The plot in which the plants were allowed to continue growth unchecked by "stopping" gave an increased crop of 19%, and the weight of fruit picked up to the end of June was similar to that picked from the control plot.

In the case of Riverside Favourite the crop from the "unstopped" plants was only 4% greater than the control and there was practically no difference in earliness. Plants "stopped" at the fifth truss and then allowed to run on, gave a slightly higher yield than those "stopped" at the fifth truss and every second truss afterwards.

These results, confirm those of previous years namely, that under the conditions operative at the Experimental Station a heavier crop is obtained when "stopping" is not practised, and the earliness of the crop is practically unchanged.

(c) Variety trials.

These trials in House 5 included (a) certain crosses between Up-to-date (resistant to *Cladosporium fulvum*) and certain well-known varieties like Tuckswood, Riverside Favourite, Manx Marvel, and Stonors M.P., (b) crosses between E.S.1 and larger fruited varieties and (c) varieties new to commerce. House 2 was devoted to testing the F 3 generations of crosses between Up-to-date and Tuckswood, Manx Marvel, Stonors M.P., Main crop and E.S.1 respectively.

Table 4.

Variety.	Grade of Fruit: percentage.								Total lbs. per plant.	Total tons per acre.
	A.	B.	C.	D.	E.	F.	G.	H.		
Tuckswood and E.S.1	56.85	27.18	4.14	7.22	4.00	—	0.61	—	6.51	49.48
Balch's Express	51.11	26.31	15.15	6.21	1.04	—	0.18	—	5.81	44.16
E.S.1 and E.S.3	69.06	19.05	7.52	3.68	0.69	—	—	—	5.72	43.47
E.S.1	65.39	24.52	2.11	4.93	1.71	—	0.96	0.38	5.23	39.75
Helvetia	65.28	24.94	3.63	5.91	—	—	0.24	—	4.41	33.52
Finchley	57.98	14.72	21.74	2.67	2.89	—	—	—	4.14	31.46
Ailsa Craig	67.54	25.17	1.69	5.10	0.25	—	0.25	—	4.13	31.39
Kondine	72.95	16.61	6.95	2.74	0.49	—	—	0.26	4.03	30.63

Table 5.

Variety.	Crop yield in lbs. per plant.						Total.	Total tons per acre.
	May.	June.	July.	Aug.	Sept.	Oct.		
Tuckswood and E.S.1	0.17	2.59	1.48	0.71	1.23	0.33	6.51	49.48
Balch's Express	0.03	1.80	1.31	0.87	1.42	0.38	5.81	44.16
E.S.1 and E.S.3	0.23	2.21	1.39	0.92	0.78	0.19	5.72	43.47
E.S.1	0.26	1.89	1.15	0.69	1.05	0.19	5.23	39.75
Helvetia	0.29	1.62	0.88	0.64	0.70	0.28	4.41	33.52
Finchley	0.26	1.54	0.74	0.40	0.84	0.36	4.14	31.46
Ailsa Craig	0.15	1.51	0.95	0.62	0.72	0.18	4.13	31.39
Kondine	0.17	1.66	0.72	0.63	0.59	0.26	4.03	30.63

Most of the crosses with Úp-to-date showed high resistance to tomato leaf mould, and certain individuals produced a satisfactory crop also. Seed has been taken from these for use in 1932. Of the other crosses and new varieties, Tuckswood E.S.1 showed the highest yield for the second year in succession. This year it gave 49.48 tons per acre. Other results will be found in Tables 4 and 5.

(d) Investigations concerning the reduction in yield of the tomato crop by continuous cultivation in the same soil.

The block of "aeroplane" type houses comprising Houses 7 to 10 was built in 1922, and cultivated for the first time in 1923. Since that time the experiments in this block have been devoted to the question of decreasing yield which invariably occurs when the tomato is grown continually in the same soil for a long period of years.

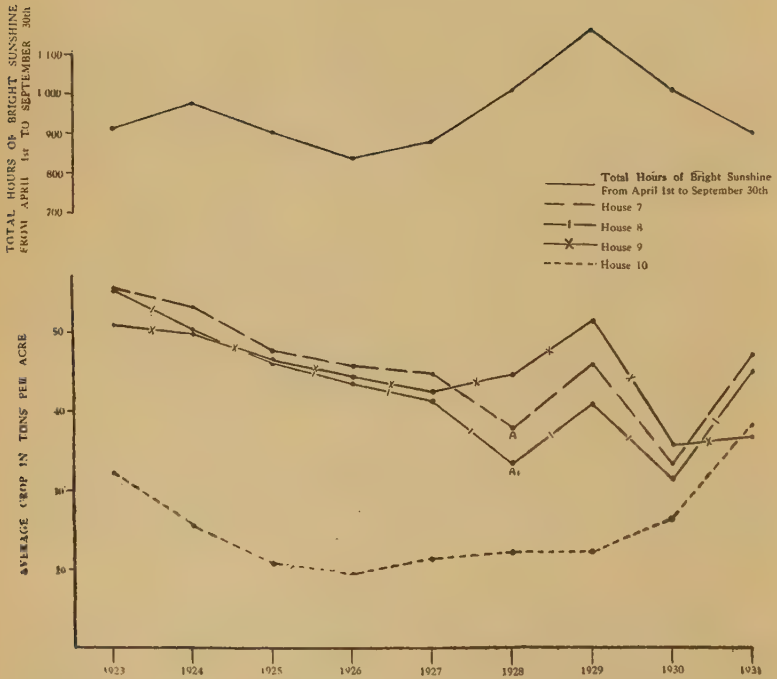
Attempts have also been made to determine the cause of this fall in yield, with the object of devising some method of regenerating the soil and so raising the yield to that obtained in the first years of cultivation. Some idea of the order in which the yield decreases with time may be obtained from Table 6, where that from individual control plots in each house is given from 1923 onwards. See also Fig. 1.

The gradual decrease in yield in each house will be noticed, except in 1927 and 1929. In the latter case the expected decrease was converted into an increase owing to the relatively great amount of bright sunshine between April and September.

Houses 7, 8 and 9 have been manured in accordance with normal practice since 1923, receiving lime, stable manure, base and top dressing fertilisers each year. Houses 7 and 8 were sterilised with steam for 1931, and House 9 sterilised with formaldehyde. House 10 remained unmanured until 1931. It received its first application of lime in 1930, and first application of stable manure in 1931. The result of these is easily seen.

The rate of decrease in yield during the first four years is similar in manured and unmanured houses. Later the yield in the manured houses continued to fall, while that in the unmanured house remained approximately constant round 20 tons per acre, which probably represents the minimum crop from this soil.

FIGURE 1.



Showing the reduction in yield which occurs when Tomatoes are grown continuously in the same soil.

Examination of the roots during and at the end of each year has shown that root decay, in which *Colletotrichum atramentarium* and numerous bacteria are associated increases in extent and starts earlier in the season as the years pass. Thus in the first year of cultivation root development was vigorous and the majority of the roots were clean at the end of the season. At the end of the second season, root action was still vigorous but a greater proportion of the root rot occurred. From the fourth to the eighth year root action become increasingly weaker, and root decay started as early as July.

The organisms isolated have not proved active parasites of healthy plants growing in new turfy soil. The extent of the injury they produce depends upon soil conditions, least damage occurring when the soil is spongy, well-aerated and well-drained.

While the possibility of toxins being left in the soil or some rare nutrient being removed from it by succeeding crops cannot be overlooked, the chief changes in the soil as the result of cultivation seem to be concerned with the coarser kinds of organic residues, and the nature of the microscopic organisms.

Plant roots in general are abundant in new land, and serve to affect ventilation and drainage to an important extent. They rarely persist in quantity beyond the third year. Such material is not applied in glasshouse practice, where green manuring is not given sufficient consideration.

Experiments conducted in these houses have shown improved crops after liberal treatment with certain green manures, with fresh grass cuttings and with plain straw respectively.

The last treatment has been used on some commercial nurseries with promising results. The nurseries in question have been those where continuous cultivation and manuring has changed the soil from the clean, open, spongy condition of virgin land to compact, badly ventilated, contaminated and over-fed state so common in old nurseries. Root development in such soils is poor, the roots become brown and diseased early in the season and the plants do not react to manurial treatments.

Wheat or oat straw, cut into 18 inch or 2 feet lengths, has been used at the rate of 6 tons per acre, applying half in the second spit and the remainder in the top spit. The straw should be laid in an oblique position approaching the vertical

and can easily be applied if the soil is dug as for bastard trenching. Afterwards the ground should be watered thoroughly to wet the straw. Stable manure is not given, but the usual treatment with lime and base fertiliser should be adopted.

This process has improved the tomato crop considerably on medium and heavy land, but on sandy soil it should not be adopted without trial on a small scale first, for the straw appears to reduce the supply of available nitrogen in the soil and on light soil, the tomato plants soon develop a pale yellowish green colour, typical of nitrogen deficiency. This can be corrected by a dressing of dried blood.

As the crop in 1930 was extremely low, Houses 7 and 8 were steamed for 1931, and House 9 treated with formaldehyde, using 1 gallon of the 40% material in 49 gallons of water to 18 square yards of soil. House 10 was not sterilised.

In Houses 7 and 8, experiments were arranged to neutralize, if possible, the effect of steaming the soil. Results are given in Tables 7 and 8.

In Plot 6, House 8, the old roots of 180 tomato plants (the plot takes 60 plants) were dug into the top 15 inches. This treatment reduced the yield 9.2% below that of the controls, and at the end of the season the roots of the plants in this plot were badly diseased. This suggests that one of the factors contributing to the decrease in yield is the accumulation of organisms which cause decay in tomato roots.

In several plots the plants were raised in pots made of wood pulp and peat in varying proportions. These plants were set out in the house, pot and all; the roots passed readily through the walls of the pots and the plants developed normally. No improvement in crop or increased earliness could be noticed from the use of these peat pots.

The incorporation of peat with the soil has been tried in previous seasons, without success. During the present season a good type of *Sphagnum* peat of only slight acidity was applied to the steamed soil and at the rate of 30 tons per acre and a formaldehyde treated plot at the rate of 15 tons per acre. In the steamed soil it increased the yield 14.15% and in the other case only 4.43%. This treatment will be repeated on a larger scale in 1932. In House 8 Plot 1 chrysanthemum roots were dug into the soil after steaming. These came from plants forced during the previous autumn. Most of the soil was removed from the roots, and the thick pieces of stem were cut away. The roots were roughly chopped up with a spade, spread over the surface of the soil and dug into the top 9 inches.

Table 6.
Crop Yield in Tons per Acre.

Year.	House 8.		House 10.		Average of all Control Plots.				Total hours of bright sunshine from April 1st to Sept. 30th.
	Plot 7.	Plot 8.	Plot 3.	Plot 8.	House 7.	House 8.	House 9.	House 10.	
1923	57.61	49.75	31.45	33.88	55.79	55.22	50.99	32.31	911.0
1924	47.73	50.39	27.05	28.58	53.09	50.38	49.77	25.55	972.3
1925	47.31	46.87	25.24	24.85	47.42	46.06	46.48	20.95	908.8
1926	43.15	42.78	20.05	16.72	44.02	40.82	44.05	19.22	838.2
1927	—	40.16	19.91	21.36	44.42	41.08	42.20	21.36	878.1
1928	33.14	37.39	19.07	17.86	37.50	33.14	44.26	21.99	1068.8
1929	40.82	44.99	32.21	32.38	45.99	40.82	51.22	21.93	1158.8
1930	27.45	25.08	30.79	31.71	33.16	26.27	35.65	*31.25	1066.1
1931	44.70	45.75	39.74	35.11	†47.08	44.70	36.76	38.10	895.9

* House 10 received its first dressing of lime in 1930, followed by complete manuring in 1931.

† House 7 and 8 steamed for 1931, House 9 treated with formaldehyde for 1931.

Table 7.

House.	Plot.	Treatment.	Grade of Fruit : percentage.								Total lbs. per plant.	Total tons per acre.
			A.	B.	C.	D.	E.	F.	G.	H.		
7	1	Steamed : Chrysanthemum. roots added	66.06	13.70	12.87	3.97	2.5	0.27	0.68	0.40	7.30	55.47
	2	" Sphagnum peat added.	72.28	13.15	9.90	2.55	1.54	—	0.43	0.15	7.07	53.74
	3a	" Planted in 60's—50% peat, 50% wood pulp.	71.46	15.56	7.46	3.88	1.30	—	0.32	—	6.18	46.90
	3b	" Planted out in 60's of wood pulp — then transplanted... ..	78.89	12.86	3.09	3.78	1.04	—	0.34	—	5.83	44.32
	4	" Heated by buried $\frac{1}{2}$ " hot water pipes—soil temp. 90° F.... ..	70.71	14.43	7.58	4.66	1.45	—	1.17	—	6.86	52.13
	5	" Ditto.—soil temp. 85° F.	73.30	14.98	4.68	4.37	0.98	—	1.69	—	7.08	53.80
	6	" Control	73.49	14.06	3.75	1.41	—	2.29	—	—	5.62	42.71
	7a	" Planted out in 60's of wood pulp — then transplanted... ..	71.32	17.21	5.23	4.16	0.34	—	1.74	—	5.74	43.69
8	7b	" Planted out in 60's—90% peat 10% wood pulp	77.32	14.08	3.06	3.06	0.94	1.24	—	0.30	6.54	49.63
	8	" Control	73.85	13.88	7.23	3.26	1.03	—	0.75	—	6.77	51.44
	1	" Soil heated 75° F.	64.98	13.59	14.55	3.79	0.65	—	2.46	0.17	6.11	46.43
	2	" Planted in containers—50% peat, 50% wood pulp	73.58	13.38	7.66	3.76	0.32	0.18	1.12	—	6.14	46.58
	3	" Ditto : containers 90% peat, 10% wood pulp.	73.12	11.64	6.64	4.22	1.14	0.17	3.07	—	6.18	46.97
	4	" Tulips in winter	68.42	15.86	8.62	4.99	0.86	0.18	1.07	—	5.80	44.09

Table 7 (continued).

House.	Plot.	Treatment.	Grade of Fruit : percentage.								Total lbs. per plant.	Total tons per acre.
			A.	B.	C.	D.	E.	F.	G.	H.		
8	5	Steamed: Tulips in winter ...	73.92	14.44	6.04	3.58	1.08	—	0.94	—	6.44	48.95
	6	Old tomato roots added.	68.52	12.54	5.62	5.62	1.30	—	6.19	0.20	5.34	40.59
	7	Control ...	69.05	14.79	9.01	3.58	0.85	—	2.72	—	5.88	44.70
	8	Soil heated 75° F. ...	64.79	14.12	13.62	4.15	0.83	—	2.32	0.19	6.02	45.75
9	1	Formaldehyde : Control ...	65.08	16.05	8.34	4.70	0.64	—	4.92	0.26	4.67	35.49
	2	" " " " " "	65.15	20.00	3.34	6.68	0.50	0.26	4.07	—	3.90	29.63
	3	" " " " " "	70.04	15.82	2.53	5.28	1.28	—	5.05	—	4.74	36.02
	4	Tulips in winter	66.37	18.32	3.48	4.88	1.16	—	5.80	—	4.31	32.76
	5	Ditto. ...	63.89	19.72	2.85	8.57	0.47	—	4.50	—	4.21	31.99
	6	Straw added ...	65.30	16.57	6.62	5.26	0.97	—	5.08	—	5.13	38.99
	7	Sphagnum peat added.	68.56	17.72	1.90	4.38	4.96	0.20	2.28	—	5.05	38.39
	8	Control ...	68.45	18.85	2.98	5.36	0.78	—	3.58	—	5.04	38.30
10	1	Unsterilised : Soil heated electrically —galvanised wires ...	53.53	27.27	7.47	7.69	0.61	—	3.43	—	4.95	37.62
	2	Control ...	70.13	19.86	4.23	3.85	0.76	—	1.17	—	5.19	39.44
	3	Control ...	71.52	19.50	3.07	4.20	0.96	—	0.75	—	5.23	39.74
	4a	New soil 1929, planted 1930 and 1931 ...	64.28	24.50	3.75	5.20	0.26	—	2.01	—	5.21	39.02
	4b	Ditto, planted first time in 1931 ...	71.88	18.44	2.65	5.59	0.72	—	0.72	—	6.18	46.97
	6	Heated as 1 ...	66.08	21.95	4.80	5.17	0.92	—	0.92	0.16	5.42	41.19
	7	Control ...	71.92	16.93	4.65	3.89	1.12	—	1.49	—	5.38	40.88
	8	Control ...	70.79	17.97	2.82	3.90	1.31	—	3.02	0.19	4.62	35.11

Table 3.

House.	Plot.	Treatment.	Crop in lbs. per Plant.							Total tons per acre.
			May.	June.	July.	Aug.	Sept.	Oct.	Total.	
7	1	Steamed : Chrysanthemum roots added	0.10	2.19	2.15	1.04	1.64	1.18	7.30	55.47
	2	" Sphagnum peat added	0.16	2.35	2.28	0.84	0.65	0.79	7.07	53.74
	3a	" Planted out in 60's—50% peat, 50% wood pulp	0.02	1.32	2.40	0.98	0.74	0.72	6.18	49.90
	3b	" Planted out in 60's of wood pulp—then transplanted	0.02	1.20	1.96	1.38	0.74	0.53	5.83	44.32
	4	" Heated by buried $\frac{1}{2}$ " hot water pipes—soil temp. 90° F.	0.14	2.15	2.14	0.82	0.93	0.68	6.86	52.13
	5	" Ditto.—soil temp. 85° F.	0.08	2.46	2.01	0.77	0.81	0.95	7.08	53.80
	6	" Control	0.08	2.03	1.53	0.85	0.49	0.64	5.62	42.71
	7a	" Planted out in 60's of wood pulp then transplanted	0.10	1.10	1.56	0.98	1.20	0.98	5.74	43.69
8	7b	" Planted out in 60's 90% peat, 10% wood pulp	0.02	1.58	2.26	1.08	0.72	0.88	6.54	49.63
	8	" Control	0.04	1.96	2.15	0.90	0.62	1.09	6.77	51.44
	1	" Soil heated 75° F.	0.13	1.83	2.08	0.86	0.54	0.67	6.11	46.43
	2	" Planted in containers—50% peat, 50% wood pulp	0.01	1.55	2.27	0.80	0.70	0.81	6.14	46.58
	3	" Ditto. Containers 90% peat, 10% wood pulp	0.02	1.53	2.18	0.87	0.80	0.76	6.18	46.97
	4	" Tulips in winter	0.02	1.63	1.94	0.82	0.75	0.64	5.80	44.09
	5	" Ditto.	0.02	2.01	2.07	0.81	0.84	0.69	6.44	48.95
	6	" Old tomato roots added	0.02	1.54	1.91	0.72	0.58	0.57	5.34	40.59
8	7	" Control	0.02	1.68	2.19	0.74	0.67	0.58	5.88	44.70
	8	" Soil heated 75° F.	0.06	1.76	2.02	0.85	0.63	0.71	6.02	45.75

Table 8 (continued).

House.	Plot.	Treatment.	Crop in lbs. per Plant.							Total tons per acre.
			May.	June.	July.	Aug.	Sept.	Oct.	Total.	
9	1	Formaldehyde :								
	2	Control	0.02	1.51	1.68	0.60	0.39	0.47	4.67	35.49
	3	"	—	1.52	1.74	0.56	0.46	0.62	4.90	37.23
	4	"	—	1.60	1.50	0.59	0.49	0.54	4.74	36.02
	5	Tulips in winter	—	1.50	1.32	0.68	0.42	0.39	4.31	32.76
	6	Ditto.	—	1.44	1.43	0.57	0.24	0.43	4.21	31.99
	7	Straw added	—	1.47	1.86	0.68	0.38	0.73	5.13	38.99
	8	Sphagnum peat added	—	1.30	2.00	0.58	0.44	0.73	5.05	38.39
		Control	0.02	1.50	1.80	0.61	0.53	0.58	5.04	38.30
10	1	Unsterilised :								
	2	Soil heated electrically—galvanised wires	1.24	2.04	0.66	0.37	0.20	0.44	4.95	37.62
	3	Control	0.79	2.53	0.59	0.43	0.34	0.51	5.19	39.44
	4a	Control	1.33	2.09	0.60	0.36	0.34	0.51	5.23	39.74
	4b	New soil 1929, planted 1930 and 1931	1.23	1.93	0.89	0.32	0.32	0.52	5.21	39.56
	6	Ditto. planted first time in 1931...	1.31	2.46	1.16	0.31	0.43	0.51	6.18	46.97
	7	Heated as 1	1.10	2.36	0.93	0.30	0.33	0.40	5.42	41.19
	8	Control	1.02	2.60	0.74	0.28	0.23	0.51	5.38	40.88
	Control	0.98	2.21	0.58	0.27	0.21	0.37	4.62	35.11	

Table 9.

House.	Plot.	Treatment.				Grade of Fruit : percentage.								Total lbs. per plant.	Total tons per acre.	Average tons per acre.
		1928.	1929.	1930.	1931.	A.	B.	C.	D.	E.	F.	G.	H.			
11	1	No lime	No lime	Lime	Lime	71.03	16.90	2.71	4.47	1.98	—	2.81	—	6.03	45.82	47.08
	3	"	"	"	"	70.60	16.50	4.24	4.90	2.05	0.01	1.30	0.30	6.36	48.34	
	2	"	"	No lime	No lime	69.70	18.17	4.48	3.48	2.02	—	1.62	0.53	7.46	56.70	49.71
	4	"	"	"	"	69.22	19.86	1.93	6.10	1.64	—	1.25	—	5.62	42.71	
12	1	Lime	Lime	Lime	Lime	73.06	8.34	7.88	3.04	1.63	—	6.05	—	4.28	32.53	33.90
	3	"	"	"	"	65.73	7.97	10.76	11.42	0.65	—	3.47	—	4.64	35.27	
	2	"	"	No lime	No lime	73.08	6.21	13.58	4.36	0.40	—	2.37	—	4.84	36.79	35.61
	4	"	"	"	"	69.30	11.07	14.79	3.98	0.66	—	0.20	—	4.60	34.43	

The result is remarkably interesting for it showed an increase of 17·82% over the control and incidentally equalled the yield from this plot in the first year of cultivation.

This experiment will be extended in 1932, for it suggests that a considerable advance has been made in the treatment of glasshouse soils. It can be reasoned that the rejuvenation of the soil is due to (a) the destruction of harmful soil organisms by steaming, (b) improved physical condition by the addition of chrysanthemum roots, and (c) the provision of the natural food for the soil organisms by the addition of the new roots.

This explanation seems most reasonable, and must be confirmed by extended investigation in the future by specially examining the effect of adding various organic materials after sterilising the soil with steam.

The experiments on soil heating have been continued and extended. They are described in a later section of this Report. The treatment of House 9 with formaldehyde is disappointing, for while the average yield per acre from the control plots in the steamed Houses 7 and 8 was 47·08 and 44·70 tons respectively, that from the formaldehyde treated House 9 was only 36·76 tons.

House 10 gave an average yield of 32·3 tons per acre in the past year. In 1929 the average yield from the control plots was 21·9 tons per acre after seven years' continuous cropping with tomatoes during which lime, stable manure and fertilisers had been withheld. One pound of hydrated lime applied in 1930 raised the yield to 31·25 tons per acre, and in 1931, after complete manuring and a second liming, this became 38·1 tons per acre.

While it may be unwise to draw deductions so soon this result seems to suggest that stable manure contributes in some way to the reduction in yield conceivably by stimulating the growth of harmful organisms or the production of injurious non-living compounds.

(e) Lime.

The liming experiment in Houses 11 and 12 has been continued. It will be remembered that when these houses were built in 1928 the soil contained only the slightest trace of lime. House 12 was limed for 1928 and 1929 while House 11 remained without lime. In both years the crop from the limed house was approximately 1 lb. per plant lower than that from the unlimed house.

In 1930, lime was added to two of the four plots in House 11, and withheld from two plots in House 12. This treatment did not affect the yield appreciably. The experiment

Table 1.

Variety—"Butcher's Disease Resister."

Treatment during 1931.										Pounds per Plant.				Total.	
	Mar.	April.	May.	June.	July.	Aug.	Sept.	Total.	Tons per acre.	Flats per foot.					
C.1	0.63	7.00	9.00	9.95	10.37	6.43	2.10	45.48	68.22	1.38					
C.3	0.29	8.17	12.38	8.83	10.43	6.22	3.40	49.63	74.45	1.51					
C.2	0.45	7.20	13.16	7.57	9.82	6.65	3.38	48.23	72.35	1.43					
C.4	0.66	6.50	11.67	9.35	9.57	5.70	2.10	45.55	68.33	1.39					
D.2	2.76	9.59	11.93	9.91	10.87	5.33	2.59	52.98	79.47	1.59					
E.3	3.49	10.04	9.77	9.63	11.98	6.52	2.20	53.63	80.15	1.63					
F.8	3.91	10.18	11.93	9.34	11.00	5.07	1.68	53.11	79.47	1.60					
D.3	2.53	10.56	11.54	9.23	10.48	5.48	2.00	51.87	77.86	1.56					
E.4	2.90	10.32	11.41	9.11	10.95	4.62	1.29	50.60	75.90	1.53					
F.2	2.67	11.33	11.50	8.01	10.32	6.81	2.68	53.32	79.98	1.62					
D.4	2.02	10.06	11.62	8.58	10.40	3.38	1.11	47.17	70.76	1.44					
F.3	2.92	9.75	11.30	8.63	9.53	7.47	1.79	51.39	77.09	1.64					
D.7	2.90	9.86	10.11	8.66	9.41	2.91	1.00	44.85	67.28	1.35					
F.4	1.85	10.44	10.91	6.82	10.68	5.32	1.19	47.21	70.83	1.44					
F.7	2.59	10.20	11.55	7.30	9.12	5.04	1.21	47.01	70.52	1.42					
D.5	3.30	9.70	12.57	9.00	10.34	4.57	1.70	51.18	76.77	1.55					
F.1	1.74	10.69	13.18	7.85	10.07	6.06	2.52	52.11	78.17	1.58					
F.5	1.82	9.62	11.88	7.40	9.28	5.29	1.50	46.79	70.19	1.41					
D.6	4.44	9.16	11.09	9.00	11.34	6.14	1.48	52.65	78.98	1.59					
F.7	3.16	9.77	10.00	8.32	8.49	5.20	1.90	46.84	70.26	1.41					
E.6	3.22	11.07	12.82	8.65	9.19	4.80	1.70	51.45	77.18	1.41					
E.5	1.53	8.13	10.88	8.07	9.84	4.36	0.81	43.62	65.43	1.32					
F.6	4.33	8.50	8.96	9.11	9.88	6.80	3.30	50.88	76.32	1.54					
D.8	2.84	10.35	10.91	9.71	10.60	5.07	2.18	51.66	77.49	1.56					

was repeated in 1931 with similar results as is shown in Table 9. While definite conclusions cannot be drawn, it would seem that the value of lime for tomato soils has been over-estimated, except in cases where it is necessary to improve the tilth.

2. Cucumber Experiments.

Previous experiments in this section have indicated clearly that failure of the cucumber plot is due to two main causes, (1) the accumulation of harmful influences in the soil under the beds, and (2) a too compact bed. The former can be corrected by steam sterilisation and the second by keeping the bed open by the use of straw and similar materials.

In the present season the experiments were devised to test the effect of adding stable manure and straw, both alone and in combination, to baked old cucumber beds and to a heavy virgin soil, kindly supplied by Mr. Horwood, of Cheshunt.

The results given in Table 1 show that the addition of straw to a normal bed of heavy soil and stable manure is a distinct advantage, but that soil and straw alone is not sufficiently rich for cucumber work. This was readily observed when the plants were growing, for those planted in heavy soil and straw without stable manure soon turned a pale green colour suggesting nitrogen deficiency. The plants developed a normal appearance after top-dressing with stable manure. No further addition of stable manure was made, nitrogen being supplied in the top-dressing fertiliser which all the plots received during the season. Where baked old cucumber beds were used, the addition of straw only gave the same yield as the addition of stable manure, but the use of straw and stable manure together resulted in a lower yield. It was interesting to note that the heavy virgin soil gave a better crop than the baked soil.

The use of peat was tested in House C., where the crop from two normal beds was compared with that from beds to which peat and turf respectively had been added. By comparing Plot 1 with Plot 4 and Plot 2 with Plot 3 it will be seen that the yield was not appreciably affected by either the turf or the peat.

The soil heating work previously confined to tomatoes was extended to the cucumber experiments with satisfactory results, for by raising the temperature of a bed 15°F. above that of the control the crop was increased from 65 tons per acre to 76 tons per acre. During the first two months of picking the crop from the heated plot was 50% greater than from the control. These experiment will be extended during 1932.

3. Lettuce.

The cultivation of lettuce as a catch crop before tomatoes has been investigated during the last four years, and on each occasion a reasonable profit has been made. It is now possible to supply details of the method adopted in the hope that growers will give it a trial. As the result of an extensive trial in 1930, when twelve different varieties were tested, Golden Ball and Improved Tom Thumb proved satisfactory varieties. Seed should be sown under gentle heat in September or early in October. An ordinary tomato seed box takes about 300 seeds. The seedlings can be pricked off into similar boxes a fortnight later, placing them half an inch apart. A mild spell of weather usually occurs about the end of November or the beginning of December. By that time the seedlings have become established in the boxes and may be transferred to an unheated tomato house, prior to planting out in December. Before standing out prior to planting it is advisable to dip each box carefully making sure it is thoroughly saturated. If not planted immediately this soaking is sufficient to last for several weeks and it is preferable to overhead watering which is liable to beat down the leaves and encourage disease. After overhead watering the small leaves cling together for several days.

Golden Ball has been found to stand the winter well in unheated houses, but Tom Thumb being of a more compact form is susceptible to attack by *Botrytis* during spells of very damp weather. It is more suitable for January planting and makes quick growth.

The houses should be manured in readiness for tomatoes and the lettuce plants set out so that the tomatoes can be planted while the lettuce plants are still in the ground. Tomatoes are planted in rows, alternately 18 inches and 27 inches apart; the lettuce plants are set out nine inches apart, three rows being planted in the 27 inch space and one row in the 18 inch space. When planting it is most important not to plant the young plants too deeply. The crowns must be raised slightly above the soil surface. Plants set out too deeply or in a depression are liable to be attacked by *Botrytis*. It is an advantage to roll the ground lightly before planting the lettuce, and an occasional hoeing and watering is all the attention they require. It is unwise to damp the lettuce plants overhead, for this encourages certain fungus diseases such as that caused by *Botrytis*. Water is usually unnecessary until February, and is best applied by fixing a piece of half inch pipe in the end of a hose, making a ring round each plant and keeping the water away from the foliage. Ventilation should be given on all suitable occasions especially

after fog. Frost injury has not been noticed during the last four years, and the plants make steady growth until the houses are heated fourteen days before planting tomatoes. The tomato plants are not injured by the presence of the lettuce and indeed seem to grow rather better. Usually the lettuce has been marketed a month after introducing the tomatoes.

Green fly occasionally attacks the lettuce, and then the tomatoes, but infestations depend upon the cleanliness of houses in which the lettuce plants have been raised and it seems an easy matter to prevent an attack by paying attention to this fact. The infestations on the tomato plants are easily destroyed by fumigation with nicotine shreds after the lettuce crop has been removed.

Variety trials will be continued during the summer, when it is hoped to discover varieties which will heart better than either Golden Ball or Tom Thumb.

4. An Oil Fuel Experiment.

The temperature experiments conducted at the Station have shown very clearly that tomato production can be raised to much higher levels by maintaining higher temperatures than those generally employed in the Glasshouse Industry, and also that uniformity of temperature is essential for good crops and freedom from disease. While much can be done by carefully organised stoking, especially at night, the human element is unfortunately not infallible and suitable mechanical devices must be sought as the best means of obtaining satisfactory temperature control.

Therefore, growers will welcome the enterprise of Messrs. Shell-Mex, Ltd., who have installed at the Station a completely automatic oil-firing equipment for the purpose of investigating the effect of temperature control in conjunction with oil fuel for glasshouse work.

The oil burning equipment serves a block of five houses, each 100 feet long and 27 feet wide, four being fitted with four rows of four inch pipes and one with six rows. The heating surface amounts to 3,080 square feet, necessitating a load of 530,284 B.Th.U's. An "Oilex" boiler kindly loaned by Messrs. Hartley & Sugden, Ltd., with a capacity of 766,000 B.Th.U's per hour is heated by a Hopes' "Quiet May" oil burner, Model "C," kindly loaned by Messrs. Hopes' Heating & Lighting, Ltd. The installation is completely automatic, being controlled by a thermostat situated at the centre of the block of houses. A block of four houses of the "aeroplane" type, each 100 feet long and 14 feet wide, heated by an anthracite fired boiler served as a basis of comparison.

Our thanks are due to Messrs. Shell-Mex, Ltd. and the other two firms above mentioned, who placed this apparatus at our disposal.

Unfortunately the present season's work is not an accurate guide to the value of oil firing. The decision to instal the oil fired boiler was not reached until after the plants had been planted in the houses, and when the "change over" was made the plants were severely checked in growth, owing to the houses being unheated for 16 hours during a particularly cold period. The result was that these plants turned blue and made little growth for about two weeks, while those in the anthracite fired houses developed normally. In spite of this check, however, the early crop was picked about the same time from both blocks. Further, the oil fired block showed an increase in crop yield over that obtained in previous years.

The system gave an excellent temperature control, especially during the early stages of growth, and tomato leaf mould, which usually appears in this block about April or May, was not observed until August, whereas it developed in the "aeroplane" block in May. These observations confirm previous results which have indicated that this disease can be kept under control by maintaining uniform night temperatures.

The experiments suggest that considerable advantages can be obtained from Temperature Control in conjunction with oil firing.

These experiments will be continued during 1932.

2. Mycological Investigations.

The following diseases not previously reported have been recorded during the year:

Host.			Disease.			Cause.
Apple	...	...	Scab	...	...	<i>Venturia inaequalis</i>
Chrysanthemum	...	...	Flower rot	...	...	<i>Botrytis cinerea</i> .
Dahlia	...	...	Crown gall.	...	...	<i>B. tumefaciens</i> .
Genista	...	...		...	...	<i>Dodder (cucusta sp.)</i>
Peach	...	...	Silver Leaf	...	...	<i>Stereum purpureum</i> .
Pear...	...	...	Scab	...	...	<i>Venturia pyrina</i> .
Poinsettia	...	...	Root rot	...	...	<i>Fusarium sp.</i>
Red Currant	...	...	Leaf spot	...	...	<i>Pseudopeziza ribis</i> .
Runner Bean	...	...	Foot rot	...	...	<i>Phytophthora sp.</i>
Strawberry	...	...	Leaf spot	...	...	<i>Botrytis cinerea</i> .
Sweet Pea	...	...	Leaf spot	...	...	<i>Cladosporium album</i> .
Tulip...	...	...	Rot of flower stalk	...	...	<i>Phytophthora sp.</i>
Zinnia	...	...	Rot	...	...	<i>Sclerotinia sclerotiorum</i> .

1. "Damping Off" of Tomato Seedlings.

P. H. WILLIAMS.

The mixture of copper sulphate and ammonium carbonate, known as Cheshunt Compound has been widely used by growers as a means of controlling "damping off" of tomato and other seedlings when this disease is due to *Phytophthora sp.* and certain closely related fungi. While it has proved satisfactory in the majority of cases, it has occasionally failed to check "damping off" on some nurseries. This has been traced to imperfect soaking of the soil in some cases, but there have been others for which no satisfactory explanation can be given, and it was decided to study the question more fully in an attempt to explain the cause of these isolated failures.

Soil which had been artificially inoculated with cultures of *Phytophthora parasitica* was used throughout the experiments. Usually it was sterilised before inoculation, but in certain cases it was used without sterilisation. Two boxes were taken for each substance under test. One was immediately immersed for twenty minutes in a tank containing the appropriate solution, while the other was soaked for a similar time in tap water. Three weeks later this second box was again treated with the substance under test by soaking for twenty minutes. The experiment was stopped

after a further two weeks. Each substance, therefore was tested both in a preventative and curative capacity. Daily counts were made of the number of healthy and diseased seedlings, the latter being removed at once. The extent of the disease was estimated by expressing the number of diseased plants as a percentage of the total germination.

Consideration of space prevents the results of these experiments being fully described, and only the most important are discussed.

Modifications of Cheshunt Compound.

These modifications were used at such strengths as would give a concentration of copper equivalent to that in normal Cheshunt Compound solution.

Mixtures in which the amount of ammonium carbonate per unit of copper sulphate was halved and doubled failed to control the disease, seedlings being scorched when a large amount of the carbonate was present.

The substitution of an equivalent amount of copper chloride for the copper sulphate in the compound was equally unsatisfactory. An ammonia solution sufficient to turn the liquid dark blue was added to solutions of copper sulphate, chloride nitrate and carbonate equivalent in copper content to Cheshunt Compound. These solutions, containing complex ammonium-copper compounds, were found to be ineffective and liable to produce scorching.

Copper sulphate was used at concentrations of 0.25%, 0.5% and 1.0%. 1.0% and 0.5% solutions proved toxic both before and after germination. At 0.25%, the control when treated at sowing was fair (44.84% of the disease in untreated boxes) but, when used after germination, the number of plants after treatment was 43% of that in the control. A slightly higher concentration might possibly give control and will be tested in the coming year.

Potassium copper sulphate has given results very similar to those obtained with copper sulphate. In boxes treated with an 0.5% solution the number of diseased seedlings ranged from 0 to 9.4% of that in the control. Treatment after germination was also successful. This concentration however, proved somewhat toxic late in the year. A slightly lower concentration will probably be of value.

A mixture of 160 parts of copper sulphate and 174 parts of Potassium sulphate gave similar results.

Potassium copper chloride and potassium copper citrate were of no value.

Germination was severely affected by solutions containing 1 part of mercuric chloride in 2,000 parts of water. No control was obtained with solutions weaker than this. A concentration of 1 in 500 killed all the seedlings when used after germination, while the disease was not checked by solutions containing 1 part in 1,000 or less. A mixture of mercuric chloride and sodium nitrate was equally ineffective.

No disease appeared in pots treated with mercuric cyanide, but the germination was seriously affected by concentrations higher than 1 in 3,000. When seedlings were treated with this substance a proportion were killed even at a strength of 1 in 3,000.

Preliminary tests in pots have been carried out with an organic mercury compound. At a normal strength of 0.25%, only 30% of the seeds germinated and 50% of these "damped off." At 0.125% germination was good, but the disease was severe. Treatment after germination failed to control the disease.

The following substances have also been tested and found to be valueless:—

Ferrous sulphate, Ferric sulphate, Potassium bichromate, Sulphuric acid, and Acetic acid.

Summary.

1. Experiments on the control of "damping off" of tomatoes are described.

2. A number of compounds have been tested, of which Copper sulphate and Potassium copper sulphate have given the most promising results.

2. The Control of Tomato Leaf Mould by Spraying.

W. F. BEWLEY AND O. B. ORCHARD.

In the 16th Annual Report, Small showed that tomato leaf mould, *Cladosporium fulvum* had been controlled on a few nurseries by spraying with Ammonium copper carbonate and Agral 1. The mixture was used at the end of the season and scorching of foliage was not observed.

Early in 1931, the mixture caused definite scorch in several tomato nurseries and severe damage in a few cases. It is possible that the absence of scorch in 1930 was due to the condition of the plants. The fact that scorching of the foliage was produced under some conditions during the spring of 1931, made it necessary to improve the mixture.

Colloidal sulphur and Agral 1 was found to check attacks of leaf mould to some extent, but the fungus grew out of the leaf again fairly quickly, and the relatively heavy deposit of sulphur on the fruit necessitated wiping it before marketing. This is a distinct disadvantage in commercial work.

The Sodium salt of Salicylanilide was also tried with Agral 1 and while pustules of the fungus were destroyed the foliage was seriously scorched. Salicylanilide itself dispersed in water as a 50% paste*, was tried in conjunction with Agral 1. This proved effective in destroying the pustules of the fungus without injuring the foliage.

Table 1 provides information relating to experiments in which the killing effect of several compounds used in conjunction with Agral 1, was tested on spore cultures and on infected plants. It was evident that $\frac{1}{8}$ -oz. Shirlan Paste in 1 gallon of water (0.078%), was sufficiently strong to control tomato leaf mould, and experiments were arranged to determine the number of applications required to check the disease once it had become well established on a nursery. From August 19th onwards badly infected plants were sprayed at weekly and fortnightly intervals, and it was found that where a second spraying had been given a week after the first application, the disease did not develop round the edge of the old pustule for another three weeks, but where the second application was delayed for a fortnight the edge of the old pustule had commenced to develop before the second spraying had been given. This has been confirmed fully by trial on commercial nurseries.

It is therefore possible to recommend the following mixture as a spray for controlling tomato leaf mould:—

$\frac{1}{8}$ -oz. Shirlan Paste. $\frac{1}{4}$ -oz. Agral 1. 1 gallon water.

The powder, Agral 1, should be sprinkled into the water and mixed by stirring vigorously. Afterwards the requisite amount of Shirlan Paste may be added and also mixed by stirring.

It is recommended that a second spraying should be given seven days after the first, and further treatment later if the disease shows signs of increasing.

In preliminary experiments, the above spray mixture has also provided a satisfactory control of cucumber mildew, *Erysiphe cichoracearum*, although it has not been possible to experiment on very young plants on a large scale and more work is necessary. Also, powdery mildew of the chrysanthemum (*Oidium chrysanthemi*), and of the rose (*Sphaerotheca pannosa*), have been controlled after a few applications, and it is possible that the spray may prove useful against other diseases of glasshouse plants.

* This has been put on the market by Imperial Chemical Industries, Ltd., as Shirlan Paste.

3. Mosaic Disease of the Tomato.

G. C. AINSWORTH.

A study of stripe disease of tomatoes has been undertaken including a comparison of this disease with "streak" produced by infection with mixed viruses.

During the past season a few striped plants occurred on the Station Nursery from which the material used was obtained.

Inoculation from striped plants into young healthy tomato plants (by pricking in the juice, friction, or incision of the stem and insertion of portions of necrotic tissue) almost invariably resulted in the development of mild mosaic. In some cases the inoculated plants also developed necrotic areas on the leaves and typical stripe lesions. Further inoculations from these latter plants gave mild mosaic and again none or a few striped plants. The number of plants developing stripe was never more than 40% of those inoculated, usually less, and towards the end of the season the number was even further reduced. Of forty inoculations from stripe plants made early in September none developed stripe.

To produce "streak" a mixture of potato mosaic virus and the mild mosaic of tomato was used. The disease produced by this mixed virus is similar in appearance to stripe but there are certain marked differences. The infection is more severe, the plants showing severe leaf necrosis and stem lesions besides being very stunted compared with healthy control plants or plants infected with mild mosaic. Artificial inoculation by friction with cheese cloth moistened with infected juice invariably gave 100% successful infections, and the incubation time is short independent of the season. During the summer five to six days, and in the winter only slightly more (six to seven days in December) when the incubation time of mild mosaic has increased to about three weeks. Working with young plants the plants are almost always killed in twelve to sixteen days.

Another difference is the response to potash. There is a marked correlation between the incidence of stripe and potash deficiency as was pointed out by Bewley (Fifth Annual Report) and his observation has been repeatedly confirmed since. For example, this year on the permanent plots, which receive the

same treatment each year and which are situated together at the north end of house 4, the percentage of striped plants on June 17th was as follows:—

Complete artificials	...	...	...	...	5.0
"	"	without potash	...	...	23.3
"	"	" phosphate	...	...	3.3
"	"	" nitrogen	...	...	1.6
"	"	with stable manure	...	...	8.3
No manure	...	...	...	...	3.3

A plant can be induced to grow out of an attack of stripe by the application of a dressing of potash. In small scale pot experiments with streak, watering with a solution of potash either before or after inoculation, proved useless as a means of control and this result is supported by results obtained on a commercial nursery last year where there was an attack of "peppery stripe" (apparently a mixed virus streak) which proved unresponsive to treatment with potash. Application of nitrogen, however, in the form of dried blood, does appear to assist the plant to outgrow the streak, although the foliage remains mottled.

The cause of stripe is still obscure. Paine and Bewley (Fifth Annual Report) showed that *B. lathryi* was capable of causing stripe but unfortunately the organism has since been lost. Others consider it to be due to a mixed virus, or to increased virulence of mild tomato mosaic in response to certain unknown conditions, or again that it is a single distinct virus.

During the season a small yellow organism similar to *B. lathryi* was isolated on several occasions from striped tomato stems and fruits but when inoculated into tomato plants failed to produce stripe. The result was also negative when tomato plants, infected with mild mosaic were inoculated. On one occasion a stripe was caused in a tobacco plant but although the organism was not re-isolated stripe could be reproduced by inserting portions of necrotic tissue into other healthy tobacco stems.

No plant infected with aucuba mosaic in the experimental house this summer developed stripe although one or two infected with mild mosaic did.

One sand culture experiment was performed to see whether nitrogen or potash deficiency would cause the development of stripe from mild mosaic or alter the percentage of plants developing stripe when inoculated from stripe material, but the result was inconclusive as no plant developed stripe.

4. Physiological Investigations of Mosaic Disease of the Tomato.

W. H. READ.

Preliminary experiments by Mr. Bolas, conducted at the Station last year, showed that there were marked local and general changes in the carbohydrate metabolism when tomato plants are inoculated with aucuba mosaic. In view of this a detailed examination of the effect of mosaic disease on the composition of the tomato plant under varying conditions has been begun. The same strain of aucuba mosaic is being used throughout. In each experiment two series of plants were taken, one batch being inoculated by friction with a bruised leaf taken from a plant infected with aucuba mosaic and the others used as controls. These control plants were kept a sufficient length of time to ensure they were not infected with mosaic disease at the time the final samples were taken for analysis. In the majority of cases samples were taken first at dusk and again after the plants had been in complete darkness for twelve hours. The amounts of total sugars, reducing sugars and starch have been determined because the available data concerning the effect of mosaic disease upon the carbohydrate metabolism is somewhat contradictory. The sugars were determined by the method of Hagedorn and Jensen after extraction by alcohol in a soxhlet apparatus and precipitation of protein, etc., with lead acetate, whilst the starch was determined in the residue from this extraction by hydrolysing with taka diastase under standard conditions and determination of the sugars produced.

Although sufficient results have not been obtained at present for any definite conclusions to be made regarding the effect of mosaic disease on the carbohydrate metabolism of the tomato plant, the preliminary results indicate that there is at first an increase over the controls in the amounts of both reducing and total sugars after inoculation with aucuba mosaic. This increase commenced about eight days after inoculation, and when at its maximum at about the twelfth day amounted to approximately 100% over the controls. Following this primary increase in the amount of sugars in plants inoculated with aucuba mosaic there appeared to be a slight decrease in the sugar content commencing at about twenty days after inoculation.

When the light intensity is so low that plants inoculated with aucuba mosaic gave distortion of the leaves without mottle or formation of yellow patches it appears that the time during which the increase in sugar content persists is longer.

5. The Nature of the Virus Principle in Mosaic Disease.

W. F. BEWLEY.

During March, 1931, a note was published in "Nature" giving certain evidence which suggested that the virus of mosaic disease is of the bacteriophage type. The evidence was as follows:—During investigations of tomato mosaic, a bacterial growth showing various forms was isolated. Stained preparations showed many bacteria in a state of breakdown.

The original isolations were prepared as follows:—Pieces of tomato stem taken from plants showing symptoms of mosaic disease and "stripe" disease were sterilised on the outside with calcium hypochlorite, and inserted into tubes of potato agar. No growth appeared for ten weeks; but in the twelfth week three tubes showed a grey-brown bacterial growth on the agar round the piece of tomato tissue.

Stained smears showed small clear areas at a magnification of 150. When examined at a magnification of 1,250 it could be seen that the bacterial cells had been destroyed, leaving a granular deposit with deeply staining fragments strongly resembling minute organisms. At other portions of the smears, certain cells were much swollen and speckled with minute darkly staining granules. Cultures of the original growth were emulsified with water, filtered through a sterile Chamberland L3 filter, and added to a broth culture of the original growth freed so far as possible from "phage." Slight clearing and diminution of the number of bacteria resulted.

In view of the conditions under which the original isolations were obtained, it seemed possible that the bacteriophage principle present in the cultures might be the virus of mosaic disease.

Consequently, a quantity of virus was extracted from a tomato plant showing symptoms of *Aucuba* mosaic disease, and some "stripe" disease. Portions of the virus which had passed through L3, L5 and L7 filters respectively under aseptic conditions were tubed separately, and were added in 1 c.c. lots to turbid potato broth cultures of the original growth which had been freed so far as possible from "phage." In twenty-four hours, the tubes receiving filtrates from the L3 and L5 filters showed slight clearing; in forty-eight hours there was definite clearing of these tubes, and in some cases very slight clearing and browning where the filtrate from an L7 filter had been added. Microscopic examination of drops from the cultures showed an appreciable diminution of bacterial numbers accompanied by apparent fragmentation

when the filtrates from L3 and L5 filters were added. Poured plates confirmed this observation.

Potato broth tubes to which an L3 filtrate of healthy tomato juice was added remained turbid, and neither decrease in the number of bacteria present nor change of form have been observed. The action of the virus seems limited to certain organisms; it did not clear mixed broth cultures prepared from soil and horse manure.

In view of these results, it was suggested that the principle causing mosaic disease of the tomato is of the bacteriophage type, which, in the first place, enters the plant with the organism it parasitises in nature and, becoming adopted to life within the tissues of the tomato plant, causes the symptoms now associated with mosaic disease.

During the latter part of March and early April fresh samples of juice were prepared from plants infected with aucuba mosaic, and also from healthy plants and filtered through L3 filters.

To five day cultures of the organism in 9 c.cs. of potato broth, 1 c.c. portion of infected juice, boiled infected juice, and healthy juice respectively were added. In the case of the infected juice there was distinct clearing of the cultures in eighteen hours, and this was more marked in twenty-four hours. After seventy-two hours, however, the cultures began to re-develop a turbidity. This observation was repeated, and confirmed.

During the last part of April and May further samples of juice were prepared from plants attacked by aucuba mosaic, mild mosaic and stripe disease, but no clearing action could be obtained with any of them.

On May 11th, to similar cultures to those not cleared by the recently extracted juices a little of the original juice extracted in February was added when clearing was marked in twenty-four hours, more so in forty-eight hours, and the cultures remained clear until the 19th, when a turbidity slowly began to develop.

Plants were inoculated with the "original" juice and developed aucuba, but juice extracted from them failed to produce clearing.

No evidence could be obtained that the "phage" multiplied in the cultures.

It will be seen that the results obtained with virus extracted during February and March have not been confirmed with later extractions, and a good deal more work is necessary before a definite conclusion can be reached.

6. Physiological Investigations of Mosaic Disease.

B. D. BOLAS.

Indications were obtained from the work included in the Report for 1930 that the progress and severity of both ordinary and aucuba mosaic in the tomato plant is in many cases connected with the carbohydrate metabolism of the infected plant. It was shown, for example that by artificially increasing the light intensity and temperature so that a high starch concentration was obtained in the leaves, typical summer symptoms could be obtained during the winter months.

Attempts were made to produce a high starch concentration in infected plants by placing the cut ends in a dilute solution of cane sugar, the shoots being exposed to normal winter daylight. In a number of cases a starch concentration, at least equal to that obtained by artificial illumination was obtained, but in no case were typical summer symptoms produced. It must however be kept in mind that the starch so produced may have differed considerably from the starch produced in the leaf by the action of light.

The transference of the infection through starch-free zones of stem and leaf was investigated by darkening zones about 1 c.m. wide by means of strips of tinfoil, leaving until the darkened zone was free from starch, as determined by experiments on control plants, and inoculating the leaves on the distal side of darkened zone. In no case was there any difference in incubation period or type of symptom. Neither was any difference obtained by the inoculation of leaves containing abundant starch and leaves free from starch provided both were placed in the same environment after inoculation.

Some evidence has been obtained that the virus in the living tissues of the tomato plant may be inactivated and destroyed by the passage of a direct electric current of suitable intensity. Such a current may apparently be so adjusted as to be non lethal to the tissues and yet to inactivate the virus. The currents used were of the order of 5.0 micro amps. per square cm. of tissue, calculated on the area of the cross sections of the tissue through which the current was flowing.

An experiment made on the distillation of infected sap at room temperature *in vacuo* confirmed the view that the infective agent is non volatile while the dry residue from the distillation remained highly infective.

Attempts to reduce the degree of adsorption of the infective agent on the living tissues were made by mixing the infected sap with a weak saponin solution. Four groups of inoculations were made using aucuba mosaic.

- (1) Control.
- (2) Inoculation by friction with filter paper moistened with 0.1% saponin in distilled water.
- (3) Inoculation by friction with infected sap diluted with an equal volume of distilled water.
- (4) Inoculation by friction with infected saps diluted with an equal volume of 0.1% saponin in distilled water.

All the plants in groups 1 and 2 remained healthy while all those in 3 and 4 developed typical symptoms of aucuba mosaic, no difference in incubation period or type of symptom being observed.

So far no evidence has been obtained that the infective agent is capable of passing through a well-made parchment paper dialyser and that any loss of potency takes place on washing away of dialisable substances from the infected sap.

None of the above results is inconsistent with the view that the infective agent is enzymic, or bacterial in its nature, or that the spread of infection is independent of carbon assimilation but that for the production of symptoms a certain rate of assimilatory activity is necessary either directly or indirectly.

3 Entomological Investigations.

1. Thrips as Pests of Glasshouse Plants.

E. R. SPEYER.

Insects commonly known as "Thrips" are at present engaging considerable attention as vectors in connection with mosaic disease, apart from the direct injury which they cause to the foliage and particularly the flowers of valuable crop-plants. The majority of species, occurring in hot-houses where tropical plants are grown, are themselves of tropical or sub-tropical origin. After control measures, which present no great difficulty, by fumigating or spraying with nicotine, have been adopted, re-infestation from outside is not to be feared.

Where commercial crops are grown, however, two distinct species of Thrips occur commonly, both of which breed upon plants in the vicinity of glasshouses in which they may be pests of a very serious nature. Owing to their habits or to the concealed positions in which they live, considerable difficulty may be encountered in obtaining control over them.

The small size and great variability in colour and structure of these insects has always made identification of the species a matter of difficulty, and it so happens that the two species here dealt with have life-histories different from one another, though, at present, the differences do not affect the measures to be adopted against them to any appreciable extent.

The Onion Thrips (*Thrips tabaci*, Lind.)

The Onion Thrips is a well-marked species which breeds parthenogenetically, no male as yet having been known to occur,* under glasshouse conditions, and inhabits the following plants grown under glass:—

(1) Cucumber.

Eggs are laid singly within the tissues of the cotyledons of pot-plants, and later in the older leaves of plants in the

* Dr. Guy Morison has very kindly sent to me from Scotland male specimens of *Thrips tabaci*, Lind., which do not agree with any male described by Priesner in his "Die Thysanopteren Europas" Vienna, 1928.

Priesner's *Thrips tabaci*, Lind., male = *Thrips fuscipennis*, Hal., typical male.

Priesner's *Thrips fuscipennis*, Hal., male = *Thrips fuscipennis*, Hal., var. *banatica* Knechtel, male.

Males of *Thrips fuscipennis*, Hal., frequently associate with females of the parthenogenetic race of *Thrips tabaci*, Lind., in flowers, and doubtless the confusion has arisen as a result of this habit.

border. The yellow larvæ feed upon the under surface and the adults often upon the upper surface of the foliage, causing white dried-up patches and hardening of growth. They are probably introduced (as hibernating adults) into propagating houses in turf used for making up the borders, so that attack may begin already in January. Periodic outbreaks last until October. Pupation takes place habitually in hollow pieces of straw lying upon the borders or mixed with the potting soil.

(2) Carnation.

It breeds within the flowers mostly of dark red or pink varieties; the larvæ and adults cause white marks upon the petals from June to November.

(3) Cyclamen.

The insect breeds within the opening flower-buds causing malformation of the whole bloom. Later the larvæ feed upon the petals which become discoloured. Infestation occurs throughout the year, but greatest injury is caused during the winter months.

(4) Chrysanthemum.

Adults collect in the flowers of bronze varieties during the winter months, and produce discolouration of the petals. No eggs appear to be laid.

(5) Arum.

Eggs are laid within the tissues at the base of the opening flower and upon its inner surface. The larvæ feed in colonies upon the more distal portions of the flower, causing large brownish patches. From June onward they breed upon plants grown out-of-doors and attacks become severe upon flowers under glass in December and January.

(6) Rose.

It breeds very sparingly within the petals of any blooms occurring from August into the winter months. Little, if any, damage is caused, and the adults, often numerous in open blooms during the winter, leave the plants in February.

(7) Tomato.

Adults cause small light marks upon the upper surface of young foliage early in the year. They probably feed at night, passing the daytime in the soil. They do not appear to breed upon the tomato plant under normal glasshouse conditions.

(8) Cinerarea.

It breeds upon the foliage of young plants early in the year.

Out-of-doors, *Thrips tabaci*, Lind., has been collected from the foliage of Onion and Dead-nettle (*Lamium*) and from flowers of Potato, Sorrel, Chenopodium, and double white Bellis during late summer and autumn.

The two pupal stages, characteristic of all species of Thrips, are passed in the soil, the larvæ quitting the plants upon which they have been feeding by jumping or falling to the ground: they do not creep down the plant stem. This habit causes a marked periodicity in the incidence of attacks.

Control Measures.

When living exposed upon the foliage of Cucumber plants, spraying with a Paraffin Emulsion, 1 part to 80 parts water, to which 95–98% Commercial Nicotine has been added at the rate of 1 part to 800 parts water, is an effective means of control. A convenient formula is:—

Paraffin Emulsion	...	...	...	1 pint.
Water	...	...	...	10 gallons.
Commercial Nicotine	...	...	2 fluid ounces.	

In cases where attacks upon the flowers of plants are to be dealt with this spray cannot be used.

For Cyclamen and Arum flowers, Naphthalene, grade 16, has given excellent control. The Naphthalene is broadcast over the plants at the rate of 10 ounces per 1,000 cubic feet space: one application has killed practically all the Thrips in all stages in very severe infestations, and very few eggs have hatched after treatment. No injury to bloom has been recorded. Owing to the probability of pupæ occurring in the soil, any control measure should be accompanied by a liberal application of water to the soil round the plants, so as to hinder the emergence of adults, and cause any straw in which pupæ may be situated upon Cucumber border to decay quickly.

This treatment is also applicable to Carnations, in the blooms of which, however, the Thrips is more difficult to control. Here the removal and destruction of any opening blooms which show indication of attack through discolouration of the petals is a useful adjunct, as such flowers nearly always contain large numbers of the insect. As many as thirty larvæ and adults have been collected from a single bloom.

The Rose Thrips (*Thrips fuscipennis*, Hal.).

The Rose Thrips causes severe injury to flowers of the Ophelia and Red Rambler types of Roses grown under glass, and during the summer of 1931 has broken out as a pest of the Cucumber plant in two widely separated localities.

This species is bisexual, males often being excessively numerous, especially upon the flowers of Bind-weed (*Convolvulus*) and other white flowers during the summer.

The Rose Thrips makes its first appearance in Rose and Cucumber houses in February. Individuals collected at this time have all been females which have over-wintered probably in crevices in the structure of the glasshouse, and have been fertilised during the previous autumn.

Adults of the first generation appeared towards the end of March, and consisted of both sexes, males being preponderant in some families, females in others.

Owing to its economic importance, an attempt has been made to unravel the systematic confusion which has arisen in the past in separating this species from its near allies. A critical examination of many hundreds of specimens collected from various plants growing both under glass and out-of-doors during the summer of 1931 gives the following results:—

(a) *Thrips fuscipennis*, Hal. Typical form.

Female, as described by Haliday. Male, described by Priesner as the male of *Thrips tabaci*, Lind.

This form occurs in the flowers of Roses grown under glass, and in the flowers and upon the foliage of the Cucumber plant. Out-of-doors it was found in the flowers of the cultivated Rose, Lupin, Sweet Pea, Tobacco, Wild Rose, *Convolvulus*, and Red Clover; occasionally in flowers of Dandelion, Iris, and *Philadelphus*; and very rarely in flowers of Carnation, *Chenopodium*, and Sorrel.

The male was found in large numbers in flowers of the Arum in which *Thrips tabaci*, Lind., was breeding, females of *T. fuscipennis* then being either absent or, when present in very small numbers, some individuals were dead.

(b) *Thrips fuscipennis*, var. *major*, Uzel, and *banatica*, Knechtel. Females. No structural characters used as means of distinguishing these two varieties from each other or from the typical *T. fuscipennis* have been found constantly to hold good. They occur in flowers out-of-doors in company with the typical form, but in smaller numbers. Isolated specimens were collected from Hawthorn and Magnolia flowers in spring and late autumn respectively. They have not been collected from plants grown under glass.

(c) *Thrips fuscipennis*, Hal., var. *banatica*, Knechtel. Male. Described by Priesner as the typical male of *T. fuscipennis*, Hal. Found only when the varieties listed under (b) have been present, except in late summer when but two specimens were collected from Rose flowers grown under glass in company with numerous typical males and females. Entirely and constantly different in characteristic structures from the typical male.

The only conclusions which can at present be drawn from the material examined are that the Rose Thrips is a variable species when inhabiting the flowers of plants grown out-of-doors as far as the female sex is concerned, and that the male sex is definitely dimorphic.

In cucumber houses in which the plants were infected with the Rose Thrips, no trace of the Onion Thrips could be found, though the latter species was prevalent in neighbouring cucumber houses. Similarly, the Rose Thrips has not been found in houses in which the Onion Thrips was present.

On the approach of winter an increase of Onion Thrips in Rose flowers grown under glass has coincided with the decrease and final disappearance of Rose Thrips, the latter species returning in February when the former appears to leave the blooms entirely. The small proportion of female Rose Thrips occurring in flowers where Onion Thrips are present is another indication that there is some antipathy between the two females, though males of the former associate freely with the latter species.

The Rose Thrips deposits about fifty eggs within the tissues of the outer petals (usually near the base) of Rose buds soon after the calyx sepals begin to separate from the corolla: it is at this time that the female Thrips feeds upon the tips of the flower petal, causing often a subsequent malformation of the whole bloom. Eggs, however, are sometimes laid near the mid-rib of the youngest leaves, and the larvæ on hatching creep into the flower buds as they open. The larva, in its second stage, does not descend to the ground as is frequent with other Thrips species, but the two pupal stages are passed amongst the petals, so that the insect is in a protected position during almost the whole of its development.

For the first time, this insect has occurred on two widely separated localities as a pest of the Cucumber plant. The eggs are laid within the tissues of the opening flower, but as the flower is of short duration the larvæ creep on to the leaves where they feed in company with great numbers of adult females; few males were found. Pupation takes place mostly in the hollow stalk-ends left after cutting off the fruit, or in crevices upon the stem of the plant.

Control Measures.

Where Roses are concerned, the control of the Thrips is a matter of considerable difficulty. Although the flower-buds show early signs of injury by which presence of the insect is early recognisable, the destruction of such buds is unlikely to be profitable as many of the lesser-affected flowers are at least marketable, and a number of eggs are laid in the young foliage. Probably the most economic means of control is spraying with the following solution:—

Potash Soft Soap (Horticultural)	...	...	2 lbs.
Rain or Soft Water	...	...	10 gallons.
95—98% Commercial Nicotine	...	...	2 ozs. (fluid).

Experiments with fumigants have been disappointing: Nicotine up to $\frac{1}{2}$ fluid oz. per 1,000 cubic feet space, and Fuse¹ Oil—which gave indications in the laboratory of being useful—up to 1 fluid ounce per 1,000 cubic feet space, both proved ineffective in glasshouses. Naphthalene does not appear to be a suitable fumigant, and oil emulsions are in all circumstances to be avoided, where Rose cultivation is concerned. When attacks upon Cucumber plants are to be dealt with the Paraffin emulsion-nicotine spray recommended for the control of the Onion Thrips appears to be a successful method of control though two successive fumigations with Naphthalene, grade 16, broadcast upon the borders, at the rate of 5 ozs. per 1,000 cubic feet gave good results upon a nursery where a large area of glass was treated by this method.

2. Red Spider Mite Control.

W. H. READ.

Further tests as to the efficiency of the sulphonated oil product mentioned last year have been conducted throughout the growing season with encouraging results. It has been established that under commercial conditions spraying with this sulphonated oil at a concentration of 1 in 240 gives a complete kill of the Mite whilst at a concentration of 1 in 300 an almost complete control is obtained with careful application. When diluted to 1 in 240 the spray mixture, unlike the more usual emulsified petroleum oil sprays, has a decided wetting effect which is much less pronounced on further dilution. No damage to young tomato or cucumber plants recently potted into "60's" has resulted from repeated applications of the sulphonated oil at a dilution of 1 in 240.

Difficulty was experienced in causing *œdema*, or dropsy, under any circumstances when conducting comparative tests as to the *œdema* promoting tendencies of the sulphonated oil and petroleum oil emulsion sprays. It was established finally

that there was a slight tendency for *œdema* to follow spraying with the sulphonated oil. The approximate cost of sulphonated oil at a spraying concentration of 1 in 240 is one half of that of petroleum oil emulsions used at their recommended strengths, and the spreading action of the former renders it somewhat more effective. An admixture of nicotine with the sulphonated oil at the rate of 6 ozs. to each gallon of oil proved very effective in controlling aphid infestations when used at a dilution of 1 in 300.

The use of glue solutions for the control of the Mite caused the leaves of the plants to stick together, and in addition fungoid growths developed in the sprayed plants. When employed at the rate of 2 ozs. of glue to a gallon of water a large number of the active Mites were destroyed, but the eggs and resting stages were mainly unaffected.

Fumigation experiments.

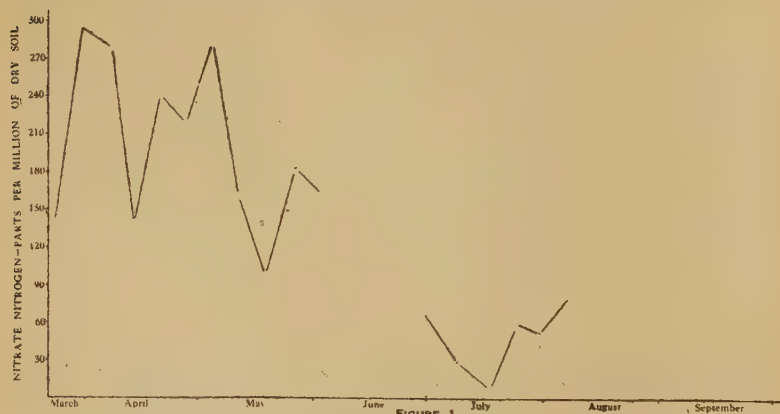
The systematic examination of different series of compounds with regard to their toxicities towards the Red Spider Mite and their action on plants was continued, and the general conclusions regarding the effect of molecular structure mentioned last year were confirmed. Although several of the substances tested showed a decided toxicity towards the Mite at low concentrations it was found impossible to destroy the Mite without damage to the plants. In general the effect of molecular structure appears even more pronounced with regard to the action of members of homologous series on plants than on the Mite.

Methyl formate is more toxic than the esters immediately following it, as the series of methyl esters of the fatty acids is ascended. This exception was noted in the series of formates of aliphatic alcohols, but methyl formate is not the most active methyl ester of the fatty acids, although it is the most toxic member of the series of formic esters of aliphatic alcohols.

4. Chemical Investigations.

O. OWEN.

For some years it has been an interesting speculation as to how much of the manure applied to glasshouse soils is lost by way of drainage. Hitherto we have had no means of determining either the amount of drainage or its composition under ordinary working conditions. An attempt has been made during the current year to rectify this lack of knowledge. For the purpose a rectangular tank made of concrete, and measuring 14 feet by 6 feet 6 inches by 2 feet, was made in one of the tomato houses. By means of a drain any drainage can be measured and collected for subsequent examination. The tank was filled with soil for the 1930 season and tomato plants grown in it in the ordinary way. It was assumed that by the commencement of the 1931 season the soil had settled down



The fluctuation in the nitrate-nitrogen content of the soil.

sufficiently to eliminate any possible effects due to the disturbance of the soil, etc. Accordingly during the season, whenever the soil in the tank was watered, the amount of effluent which ran through was measured and a sample taken for analysis. Concurrently, weekly samples were taken of the soil and these were examined for nitrates. For comparison's sake weekly samples of soil were also taken from an adjoining plot and these also were analysed for nitrates. Sampling of the soils was continued until the beginning of August. By this time the fall in the nitrate values, similar to those already recorded for other plots, had set in. The results are depicted graphically in Fig. 1. The fluctuations in the amount of effluent are shown in Fig. 3.

The chief item of interest in the effluent at the time was the amount of nitrate-nitrogen it contained. The results showing the amounts of this form of nitrogen are given in the accompanying table and shown in Figure 2. At the same time, the samples were examined for ammoniacal nitrogen ("saline" and "organic"), potash, phosphoric acid and nitrite-nitrogen.

Of great interest are the facts that in none of the samples was there more than the trace of phosphate and as a rule no nitrite-nitrogen was present. This suggests that in any chain of processes there is no definite break at a nitrite stage and further that no nitrogen is lost in this form from soil. The absence of phosphates in the leachings is easily accounted for by the fact that the soil contains an appreciable amount of lime which would fix any soluble phosphates. The nitrogen which is lost as ammonia is appreciable and, as a rule, of this, considerably more is present as "albuminoid" or "organic" ammonia than as "free" or "saline" ammonia. The whole of the nitrogen as ammonia, however is decidedly less than that present as nitrogen.

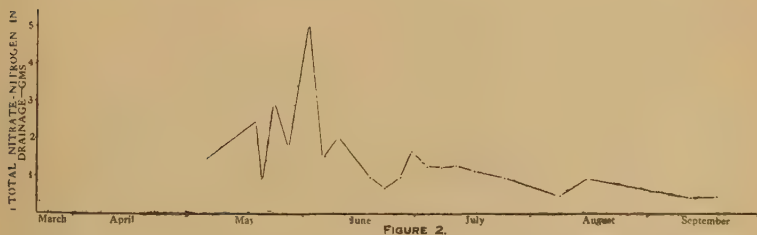


FIGURE 2.

The fluctuation in the nitrate-nitrogen washed from the soil.

Considerable losses of potash can be traced to leaching. While the complete figures are not available the data so far obtained indicate that the amount of potash lost in the drainage is considerably less than that removed by a good crop.

From the table it will be seen that the total drainage from this small plot amounted to 1,628 litres. Calculated for an acre of soil this amounts to 171,400 gallons. It is estimated that the plot has been watered at the rate of 821,300 gallons per acre per annum. So that of the water applied rather more than 20% drains away. The remainder is, of course, used in transpiration and lost by evaporation from the soil surface.

The Amount of Nitrate-nitrogen in the Drainage from Tomato Soil.

Date.			Volume in Litres.	Nitrate-nitrogen per Litre gms.	Total Nitrate- nitrogen in gms.
May	5	...	64.89	.0253	1.629
"	18	...	41.18	.0587	2.417
"	20	...	20.3	.04219	.8365
"	23	...	55.11	.05465	3.011
"	27	...	34.8	.04965	1.728
June	1	...	159.5	.03184	5.079
"	5	...	55.11	.02523	1.390
"	9	...	75.41	.02688	2.027
"	12	...	78.3	.02323	1.445
"	18	...	46.4	.02099	.9738
"	22	...	31.9	.01697	.6316
"	26	...	78.3	.01262	.9883
"	29	...	81.2	.02028	1.647
July	3	...	87.06	.01451	1.263
"	6	...	64.39	.01869	1.203
"	10	...	104.4	.01203	1.256
"	15	...	142.1	.007749	1.101
"	23	...	81.2	.01170	.9501
Aug.	8	...	46.4	.01086	.5037
"	15	...	116.0	.007977	.9253
Sept.	12	...	23.2	.01888	.4381
"	19	...	40.6	.01189	.4826
Total ...	...	...	1627.75		31.996

The nitrogen in the form of nitrates in the drainage amounts to 31.996 gms. This corresponds to an annual loss of 33.81 lbs. per acre or 169 lbs. of sulphate of ammonia. The loss of nitrogen as ammonia is considerably less than this and probably does not amount to more than about a tenth. These values may be compared with the values given for nitrogen removed by the crop. On the basis of figures obtained in work recorded in earlier reports it was estimated that under the conditions obtaining at the Station, a 40-ton crop removed 344 lbs. of nitrogen. It is seen that this is approximately ten times greater than that lost in drainage. These indicate that about half the nitrogen applied in manures is bound up in the soil.



FIGURE 3.

The fluctuation in the amount of drainage.

An examination of the curves in Figures 1 and 2 shows that, in general, the fluctuations in the amount of nitrate nitrogen in the drainage follow the fluctuations in the amount of nitrates in the soil. That is to say, the nitrates lost in drainage are highest in the early parts of the year when the nitrate content of the soil is high. This lends support to the view held in earlier reports that the chief loss of nitrogen during and after watering is through leaching.

It is proposed to repeat and amplify this work during 1932.

5. Temperature Investigations.

(1). The effect of ventilation on the Air Temperature of Glasshouses.

O. B. ORCHARD and W. F. BEWLEY.

The effect of roof ventilation on the air temperature of certain glasshouses has been studied. Records were made by means of thermographs placed eighteen inches above the soil, No. 1 being placed six feet from the north end and No. 2 six feet from the south end of the house. Houses 11 and 12 were selected for the experiment, being two single houses separated by a partition. Readings were taken over periods of a week except during September, when daily periods were compared.

In the first experiment a temperature of 60-65°F. was maintained by applying top ventilation in accordance with what is regarded as correct practice, prevailing winds, sunshine, etc., being taken into consideration. The other house was not ventilated.

The following table indicates that when the ventilators were opened 2-4 notches daily during the month of March, the mean temperature was not affected as much as might be expected. This may be due to the fact that, at this time of the year, maximum day temperatures are comparatively low, and therefore the loss from the closed house by radiation from the glass would be much greater than when the temperature outside was higher. Consequently heat lost by ventilation would not be so great in proportion to that lost by radiation.

In the second experiment one house was ventilated on the correct or leeward side, while in the other the ventilators were opened to the same extent on the windward side.

The records given in Table 2, show that the effect of ventilating on the wrong side is greatest when outside temperatures are lowest, and that incorrect ventilation in the middle of the year does not affect the house temperature to any extent.

In the third experiment both houses were ventilated on the correct side, one being given twice as much ventilation as the other. Observations in Table 3, suggest that the extent to which the ventilators are opened does not matter so much provided they are opened on the leeward side of the roof.

Table 1.

Date. Week Commencing.	House Closed.				Correct Ventilation.				Outside Temp		Prevailing Wind and Force.	Average Sunshine per Day. Hours.
	No. 1.		No. 2.		No. 1.		No. 2.					
	Mean Day.	Mean Night.	Mean Day.	Mean Night.	Mean Day.	Mean Night.	Mean Day.	Mean Night.	Mean Max.	Mean Min.		
March 9th ...	62.8	55	65.8	55.8	62.5	60.0	65.0	58	46	27	N. 2.	5.0
July 21st ...	68.5	64.80	65.5	64.5	62.8	60.0	62.2	6.18	74	54	S.W. 2.	6.0
Sept. 9th ...	70.0	63.50	69.6	62.2	62.8	56.5	62.8	57.50	60	41	N. 1.	6.2

Table 2.

Date. Week Commencing.	Correct Ventilation.				Vents Opened Windward Side.				Outside Temp.	Prevailing Wind and Force.	Average Sunshine per Day. Hours.
	No. 1.		No. 2.		No. 1.		No. 2.				
	Mean Day.	Mean Night.	Mean Day.	Mean Night.	Mean Day.	Mean Night.	Mean Day.	Mean Night.			
	Mean Max.	Mean Min.									
March 21st	64.5	61.0	67.5	61.0	60.0	55.5	66.4	57.4	60	42	4.0
August 4th	66.5	58.5	66.3	61.8	65.8	59.5	66.0	60.0	68	49	5.0
Sept. 14th...	70.0	61.0	68.0	64.5	67.0	65.0	63.5	60.8	67	51	7.2

Table 3.

Date. Week Commencing.	Half Ventilation.				Full Ventilation.				Outside Temp.		Prevailing Wind and Force.	Average Sunshine per Day. Hours.
	No. 1.		No. 2.		No. 1.		No. 2.		Mean Max.	Mean Min.		
	Mean Day.	Mean Night.	Mean Day.	Mean Night.	Mean Day.	Mean Night.	Mean Day.	Mean Night.				
March 31st	60.0	57.2	61.0	57.2	58.2	52.2	61.0	57.0	54	39	S. E. 2.	2.2
August 13th	67.0	63.0	70.0	61.0	66.0	61.5	67.0	61.0	63	45	S. W. 2.	5.8
Sept. 1st ...	65.2	61.5	65.5	61.0	62.0	60.0	64.2	60.2	65	51	S. W. 1.	2.2

It is obvious that a great deal of work must be done before accurate information can be provided, but the above results suggest that the effect of ventilation on the air temperature of the houses is by no means constant, and that growers cannot regulate it accurately without referring to thermometers, which should be more extensively used than they are in present practice.

(2). Soil and Air Temperature.

The experiments conducted during 1928 and 1929 in House 6 for the purpose of determining the most suitable air temperatures for the tomato were continued during the present year. This house is divided into six chambers, the soil of Chambers Nos. 2 and 4 being heated during the first ten weeks of the season by means of buried electric resistance wires.

Chamber No. 1 was again used for a carbon dioxide experiment. The rest of the chambers were thermostatically controlled to maintain a minimum night air temperature of 68°F. in Nos. 2 and 3 and 63°F. in Nos. 4 and 5. The thermostatic controls of the heating system in these chambers are accurate to plus or minus 2°F. - 3°F.

Electric power was automatically applied to the cables by means of a time-switch acting between the hours of 10 p.m. and 6 a.m. each night from February 18th until April 25th. By this means, the soil of Chambers Nos. 2 and 5 was maintained at a temperature of 70°F.

Chamber.	Mean Air Night Temp.	Mean Soil Temp.	Lbs. per Plant to end of June.	Total Lbs. per Plant.	Total Tons per Acre.
2	68°F.	70°F.	2.38	5.80	44.09
3	68°F.	65°F.	2.26	5.21	40.13
4	63°F.	70°F.	2.43	5.30	40.28
5	63°F.	64°F.	2.05	4.85	36.87

Past experiments have suggested that with normal soil temperatures the most suitable night temperature is about 63° or 65°F. but it can be seen from the present experiments that slightly higher air temperatures will produce a still greater yield if the soil temperature is also raised.

The experiments with soil heating were extended to cucumbers, the heating cable being placed at the bottom of the bed. Results were distinctly promising for an increase in crop production amounting to 50% was recorded for the first six weeks of picking. At this point heating was stopped

and no further crop increase was noted until late in the season when heating was restarted. The crop return immediately increased above that from the control plot and the heated bed was the only healthy plot at the end of the season.

These experiments are being extended during 1932.

In view of the relatively high cost of heating the soil in tomato houses by means of electricity, an experiment was arranged to see if the soil could be heated by circulating hot water through buried pipes.

Messrs. Richard Crittall & Co., Ltd., very kindly offered to install suitable apparatus for this purpose, and two plots, 4 and 5, at the south end of House 7 were set apart for the experiment. A series of half-inch hot water pipes were buried fifteen inches below the surface, and connected to the ordinary hot water pipes in the house so that hot water from a flow pipe was circulated through the buried pipes and picked up by a return pipe. An electrically driven pump was used for this purpose.

The soil was heated quickly and the two plots were maintained at approximately 85°F. and 80°F. respectively. It is interesting to note that the temperature of the soil near the pump remained around 100°F. for four weeks without injuring the plants in any way. The accompanying table shows the weight of fruit obtained, and the mean weekly temperatures. Plot Nos. 3 and 6 in the same house were used as controls.

Plot No.	Temp. °F.	Lbs. per Plant.			Lbs. per Plant end of July.	Total Lbs. per Plant end of year.
		May.	June.	July.		
3	62	0·02	1·20	1·96	3·18	44·32
4	84	0·14	2·15	2·14	4·43	52·13
5	78	0·08	2·46	2·01	4·55	53·80
6	62	0·08	2·03	1·53	3·64	42·71

These results show a crop increase of 23·6% and 19·1% from the heated plot for the whole season, and a 33·4% and 30% increase in the crop picked up to the end of July. The experiments will be repeated.

6. Miscellaneous Investigations.

The use of Electric Light in the Propagation Houses.

W. F. BEWLEY.

Experiments designed to study the effect of exposing tomato seedlings and young plants to light from electric lamps during the period November to January inclusive were continued. The source of light was a 500 watt gas-filled lamp fitted with a white enamelled reflector, 17 inches in diameter. This was suspended two feet above the bench giving an illumination of about 200 foot candles on the plants, the figure of merit being of the order of 14·5.

Previous experiments suggested there was considerable improvement in growth when six hours electric light was given during the normal period of darkness.

During six weeks, commencing November 9th, the following experiments were conducted:—

- (1). Electric light from 9 a.m. to 6 p.m.
- (2). " " " 9 p.m. to 6.30 a.m.
- (3). " " " 4 p.m. to 10 p.m.
- (4). " " " 6.30 a.m. to 9.30 a.m.
 and 4 p.m. to 7 p.m.

In each case growth was greatly improved by the additional light. If anything, the best effect was provided by illumination from 6.30 a.m. to 9.30 a.m. and 4 p.m. to 7 p.m., but the difference was so slight that in the later experiments the more convenient system of illuminating between 4 p.m. and 10 p.m. was adopted.

In the second experiment it was arranged to grow 500 plants for planting in the chambers in House 6. 100 plants were placed under each of five lamps, and received six hours electric light per twenty-four hours from 4 p.m. to 10 p.m. An attempt was made to grow the plants as well as possible, taking advantage of the extra illumination; and to counteract the high temperatures produced by the electric lamps, the houses were ventilated whenever the lights were in action.

Growth was remarkably good until January 23rd, when a period of foggy weather lasting some fourteen days prevented the necessary ventilation from being applied and seriously affected the plants.

Ultimately the experiment was stopped, for the plants lost their roots and became unsuitable for planting in the houses.

A good deal of information has been gained from this failure, and it is hoped to improve conditions next autumn when the experiments will be repeated.

The chief difficulty with this type of experiment is the unsuitability of the lamps, owing to the generation of so much heat. Lamps and discharge tubes of various types are under examination and a suitable source of illumination may be obtained ultimately.

APPENDIX A.

Manurial Treatment in the Tomato Experiments.**(1) Lime.**

All Houses except No. 1, 11 and 12 received ground caustic lime at the rate of 2 tons per acre.

(2) Stable Manure.

Houses 5 and 6 received 30 tons and Houses 9 and 12 received 15 tons per acre.

(3) Base-dressing,

Houses 1, 2, 7 and 8 were steamed and received 10 cwts. Sulphate of Potash only per acre.

House 5 received $\frac{3}{4}$ -lb. per sq. yd. of the following mixture:—

- 1 part bone meal.
- 1 part bone flour.
- 1 part ground hoof and horn.
- 1 part sulphate of potash.

Houses 8, 9, 11 and 12 received the following per sq. yd.

- $\frac{1}{4}$ -lb. bone meal.
- $\frac{1}{4}$ -lb. bone flour.
- $\frac{1}{4}$ -lb. sulphate of potash.

(4) Top-dressing.

Houses Nos. 2, 5, 6, 7, 8, 9, 10, 11 and 12 received 2 ozs. per sq. yd. of the following mixture every 14 days at discretion:—

- 3 parts sulphate of ammonia.
- 2 parts dried blood.
- 7 parts 30% superphosphate.
- 5 parts pure dissolved bones.
- $\frac{1}{2}$ part bone flour.
- $2\frac{1}{2}$ parts sulphate of potash.

This gave 5% ammonia, 24% total phosphates, 12% soluble phosphates, and 7% potash on examination,

APPENDIX B.

**Manures applied to Plots 1-3, and 14-16 in Tomato
Houses 3 and 4.**

Plot.	TITLE.	Base Manure in Lbs. per sq. yd.				† Top-dressing in Lbs. per sq. yd.			
		Lime.	Stable Manure.	Basic Slag.	Sulphate of Potash.	Super- phosphate.	Sulph. of Ammonia.	Nitrate of Soda.	Sulph. of Potash.
1	Complete Artificials (I.) without Nitrogen	1.0	—	0.4	0.1	0.5	—	—	0.2
2	Unmanured	1.0	—	—	—	—	—	—	—
3	Complete Artificials	1.0	—	0.4	0.1	0.5	0.2	0.2	0.2
14	Complete Artificials with Dung	1.0	7	0.4	0.1	0.5	0.2	0.2	0.2
15	Complete Artificials without Phosphates	1.0	—	—	0.1	—	0.2	0.2	0.2
16	Complete Artificials without Potash	1.0	—	0.4	—	0.5	0.2	0.2	—

† The Top-dressing was applied in eight equal instalments.

Manurial Treatment in House 3, and Plots 4-13 in House 4.

FERTILISERS IN POUNDS PER SQUARE YARD.

House.	Plot.	Base.					Top-dressing.					
		Bone Flour.	Sulphate of Potash.	Cyanamide.	Hoof and Horn.	Shoddy.	Sulph. of Ammonia.	Nitrate of Soda.	Nitrate of Lime.	Dried Blood.	Peruvian Guano.	Fish Manure.
3	1 5 10 14	0.25	0.25	—	—	—	0.48	—	—	—	—	—
3	2 6 9 13	0.25	0.25	—	—	—	—	0.65	—	—	—	—
3	4 8 11 15	0.25	0.25	0.64	—	—	—	—	—	—	—	—
3	3 7 12 16	0.25	0.25	—	—	—	—	—	0.93	—	—	—
4	7 12	0.25	0.25	—	—	—	—	—	—	0.86	—	—
4	4 10	0.25	0.25	—	0.86	—	—	—	—	—	—	—
4	5 9	0.25	0.25	—	—	—	—	—	—	—	0.80	—
4	8 11	0.25	0.25	—	—	—	—	—	—	—	—	1.18
4	6 13	0.25	0.25	—	—	0.86	—	—	—	—	—	—

APPENDIX C.
 Dates of Cultural Operations during 1930—1931.

Crop.	Sown.	Potted into 60's.	Potted into 32's.	Planted out in borders.	First Mulching.	First Top Dressing.	First Fruit picked.	Last Fruit Picked.
Cucumbers ...	Dec. 10 1930	Dec. 18 1930	Jan. 3 1931	Feb. 12 1931	Mar. 1 1931	Mar. 8 1931	Mar. 13 1931	Sept. 18 1931
Tomatoes ...	Dec. 10 1930	Jan. 1 1931	—	Feb. 20 1931	—	May 9 1931	May 15 1931	Oct. 20 1931

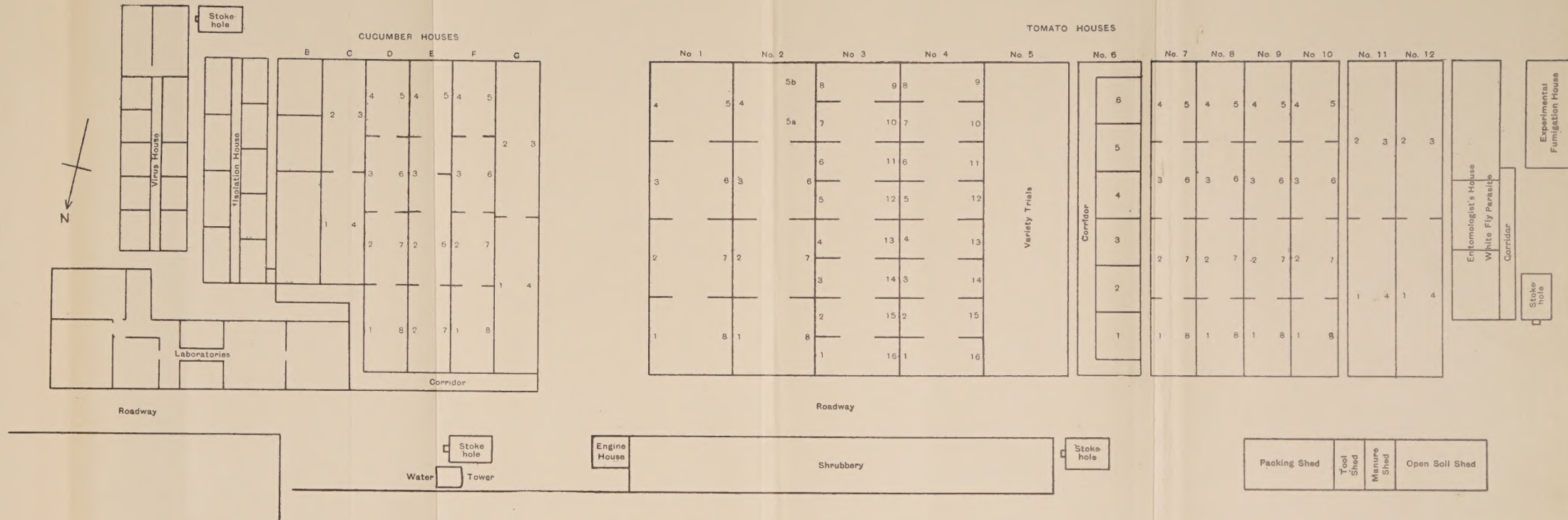
Month.	Air Temperatures						Grass Temp.		Rainfall				Mean Soil Tem- peratures		Hygrometer				Bright Sunshine		Baro- meter	
	Mean		Absolute Max.		Absolute Min.		Av. Min.	Absolute Min.		Total Pre- cipitation	No. of Days of P. fts	Greatest Fall		Soil Tem- peratures		Dry Bulb	Depos. of Wet Bulb	Relative Humidity	Dew Point	Total Daily No. of Aver. Hrs.		Bright Sunshine
			°F.	Date	°F.	Date		°F.	Date			1 ft.	2 ft.									
	°F.	Min.	°F.	Date	°F.	Date	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.		°F.
January	44	32.5	52	19th	23.5	5th	30.6	22	{ 5th 9th	1.87	19	31	31st	38.7	40.3	37.4	0.84	92.5	34.5	66.9	2.3	29.885
February	46.3	33.2	58	{ 1st 25th	27.5	4th	31.6	24	21st	1.90	18	49	11th	38.4	39.7	37.6	1.25	87.0	35	62.2	2.2	29.788
March	48.2	31.6	69	20th	17	9th	31.3	16.5	9th	0.07	5	03	8th	39.2	40.5	41.6	2.0	87.0	38.3	139.3	4.4	29.657
April	55.5	40.5	68	11th	33	{ 17th, 21st	38.8	29	21st	3.77	17	49	25th	42.4	43.4	48.3	2.0	82.3	42.3	103.2	3.3	29.400
May	61.8	41.9	76	27th	36	20th	43.5	31.5	4th	2.04	14	48	23rd	56.2	51.8	55.8	2.8	72	51.0	159.7	5.17	29.930
June	70.2	52.4	78	{ 14th 27th	41	24th	45.5	38	24th	1.29	12	45	5th	61.5	60.2	63	2.9	82.4	66.8	202.4	6.7	30.064
July	70	51.5	80	{ 3rd 12th 24th	42	20th	51.2	42	{ 6th 20th	2.48	13	72	14th	63	62.5	64	2.7	81.5	63.6	157.3	5.07	29.797
August	64.8	48.8	79	1st	32.5	25th	49	35	23rd	5.13	17	85	4th	61.5	60	59.4	1.8	82.0	58.0	162.6	5.8	29.266
September	61	42.5	72	16th	33	7th	42.4	32	6th	3.30	14	136	3rd	56.2	56.8	55	1.4	85.0	52.3	110.7	3.7	30.036
October	57.8	36.4	67.5	6th	21	27th	36.5	20.5	27th	0.58	4	29	29th	50	51.8	50.8	1.3	91	47.0	118.0	3.8	30.046
November	52.8	34.2	62	3rd	28.5	1st	33.4	27	1st	2.01	17	67	6th	45.6	45.2	46	0.6	95	46	49.3	1.6	29.243
December	41.2	34	60	4th	18	31st	32.3	17.5	31st	0.43	8	17	2nd	42.2	43.8	39.5	0.7	96	37	34.4	1.14	29.816

Total rain for year, 24.87 ins.

No. of days precipitation, 158.

Total bright sunshine for year, 1,296 hours.

DIAGRAM SHOWING ARRANGEMENT OF EXPERIMENTAL PLOTS, 1931.



APPENDIX E.

List of Subscribers to the Laboratory Extension Fund, 1931-32.

Messrs. Allen & Hanburys, Ltd.

Chilean Nitrate Committee.

R. Cory, Esq.

County of London Electric Supply Company, Ltd.

Imperial Chemical Industries, Ltd.

Lord Iveagh.

H. O. Larsen, Esq.

Messrs. Lowe & Shawyer.

Messrs. Geo. Monro & Sons, Ltd.

National Federation of Fruit and Potato Trade
Association.

Messrs. Francis Nicholls, Ltd.

J. Nielsen, Esq.

A. A. Pollard, Esq.

Messrs. T. J. Poupart, Ltd.

Messrs. Robinson Bros., Ltd.

Messrs. Thomas Rochford & Sons, Ltd.

C. H. Shoults, Esq.

Messrs. E. Stevens, Ltd.

Thames Bank Iron Company, Ltd.

Tottenham and District Gas Company, Ltd.

United Potash Company, Ltd.

